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ABSTRACT

Organized as a teaching outline for an industrial plant fire brigade course, this manual contains a rationale for an industrial plant brigade as an adjunct to the local firefighting services; information to the instructor concerning the implementation of an industrial fire brigade program; and a teaching outline consisting of eleven sections: (1) organizing a brigade, (2) salvage operations, (3) chemistry of fire, (4) portable fire extinguishers, (5) breathing equipment and protective clothing, (6) ladder practices, (7) handling the fire hose, (8) forcible entry, (9) rescue and first aid, (10) sprinkler systems, and (11) fire causes and hazards. Each section delineates the use of tools and the task-oriented process. References are also listed for each. (VB)

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ED155375

INDUSTRIAL FIRE BRIGADE TRAINING

DEPARTMENT OF COMMUNITY COLLEGES
STATE BOARD OF EDUCATION
RALEIGH, NORTH CAROLINA

U.S. DEPARTMENT OF HEALTH, EDUCATION & WELFARE
NATIONAL INSTITUTE OF EDUCATION

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TO THE EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC) AND USERS OF THE ERIC SYSTEM."

OE 016676

PREFACE

If today is an average day in the United States, four hundred industrial plants will be either destroyed or damaged by fire. Tomorrow morning, as the result of these fires, two thousand people will be out of work.

Uncontrolled fire in industrial plants can destroy both life and property; it can impede the normal flow of business. Our State's economy can be hurt and our national security can ultimately be affected by the loss of commodities destroyed in plant fires. Fires that can cause such great destruction demand attention.

One means of avoiding major industrial plant fire losses in North Carolina is for each plant in the State to maintain a well-trained fire brigade. Each brigade should be prepared to meet the specific needs of the plant which it serves. It is not the intention that an industrial plant fire brigade take the place of the local fire department. However, it is the responsibility of the brigade to take action during the first crucial minutes of a fire. These initial steps can help prevent costly fires.

A fire in ordinary combustibles multiplies fifty times in volume within the first eight minutes. For this reason it is easy to understand why each industrial plant should have a proficient fire brigade that is immediately available when fire strikes. This is the means through which management can protect the company against fire losses that may adversely affect profits and interrupt the continuity of business.

TO THE INSTRUCTOR

When an instructor is preparing to train persons for Industrial Fire Brigades, he should give careful consideration to the fact that industry is a separate entity with its own form of government and administration. Conditions that pertain to the physical plant, personnel relationships, and plant production are peculiar to industry.

Industrial hazards are general in nature with no two situations identical. Each hazard must be treated as a new problem. A thorough study of the unique facilities and hazards found in each plant must be made before specific training can be planned.

Fire protection is the responsibility of management. For this reason management should be informed of any possible work interruptions related to the training program. Management should also be informed of the cost of the program and should approve of the subjects to be taught.

New programs in Fire Brigade Training should not be started until the nearest area coordinator in fire service training has had an opportunity to consult with the industry involved and with the instructor to insure that the needs are being met and the program will operate efficiently.

The area coordinator should be contacted whenever additional information is needed. This will provide a better understanding of a specific problem and its solution.

The Industrial Fire Brigade material in this publication has been organized as a teaching outline and is not intended to be a textbook. Therefore, the instructor must use the references indicated at the end of each chapter in order to teach the course efficiently.

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PART I: ORGANIZATION

I. Gaining the Cooperation of Plant Management.

A. A fire brigade will be successful only if it is recognized by plant management as an important permanent department.

B. Equipment must be purchased for fire protection and training of the brigade.

C. Time must be allotted for the training program and many other situations will develop which will require the backing of the plant management.

D. The plant management and the plant fire brigade have special responsibilities. Management must see that protection schedules are maintained; the fire brigade must see that the instruments of production--plant and equipment--are kept intact.

E. Without the cooperation of management and the fire brigade to the fullest extent, an uninterrupted flow of finished products cannot be maintained.

F. Plant management can do much toward making a fire brigade efficient and its members willing to work hard for plant security.

1. Establishment of authority in the plant for members of the fire brigade.

a. Will do much to enforce fire prevention rules.

b. Will give the member a sense of responsibility for plant fire safety.

c. Can be done by issuing badges to the fire brigade members.

2. Establishment of a meeting place or classroom for the fire brigade.

a. Should be equipped with blackboard and other necessary equipment for teaching.

b. Can pay large dividends, not only in the training of the fire brigade but in the activities, which make membership in the brigade desirable.

II. Determining the Size of the Fire Brigade.

A. The size of the fire brigade and the necessary equipment will depend largely upon several factors.

1. Size of plant--floor space or area covered.

2. Nature of plant's fire hazards, determined to some extent by the type of production.

3. Availability and amount of help which can be expected from local fire department.

B. When the size of the fire brigade has been determined, the necessary companies can be decided upon.

C. The fire brigade should be made up of companies, each consisting of five to ten men selected from the various departments.

D. In general, the men should be familiar with the various processes, arrangements, exits, etc., of the entire property.

E. In plants having fire pumps, the engineer or his chief assistant should be a member of the fire brigade.

III. Enlisting Fire Brigade Personnel.

A. Three rules should be followed in selecting fire brigade personnel.

1. Every member must be able-bodied.

2. All members must be available for fire duty in accordance with a prearranged schedule.

3. All members must have ability and willingness to take training.

B. Certain handicaps make fire fighting impossible even though the man may be willing and anxious to become a member of the fire brigade.

C. In plants where work is performed on more than one shift, it is better to select men from all shifts to assure a fire fighting group in the plant at all hours.

D. Some plants follow a plan of zoning whereby men are selected from all shifts in the zones.

E. When selecting men for the fire brigade, attention should be given to the interest of individuals and to their ability to comprehend special training.

F. Fire fighting requires the use of scientific methods and to do the job well, understanding of what to do is essential, along with a willingness to serve.

IV. Selecting a Fire Brigade Chief and Other Officers.

A. In large plants the fire chief preferably should be employed full-time.

1. The chief must have complete support from plant management.

a. Authority must be clearly defined and understood by his plant associates.

b. Chief must be given opportunity to advise on fire safety.

c. He should be consulted prior to construction and equipment changes.

2. Fire chief must have knowledge of fire fighting and fire prevention measures.

3. Since the training of the fire brigade is under his supervision, the fire chief must be acquainted with training methods.

4. Some of the important characteristics of a good brigade fire chief:

a. Technical competency in the fields of fire prevention, fire protection and fire fighting.

b. Proficiency as a trainer.

c. Ability to direct the activities of others.

d. Ability to command respect at all levels in the organization.

B. The brigade fire chief should have an assistant.

1. Assistant should have qualifications similar to those required of the chief.

2. He should assist the chief and be able to take charge in his absence.

C. Captains should head the various brigade companies.

1. A captain's qualifications:

a. Must be a responsible person.

b. Must be able to handle men.

c. Must be able to lead in the work of the fire brigade.

2. Captains should be persons who are willing to take special training.

V. A Program of Training.

A. To be successful, a definite training course should be prepared to meet the needs of the plant in which the brigade is employed.

B. The course should be followed through by refresher and updating sessions and drills properly supervised by a trained instructor.

VI. Selecting the Instructor.

A. He must have a desire to teach.

B. He must have a sincere desire to be helpful.

C. He must have knowledge of the subject and be trained to teach others.

VII. Planning and Following a System of Training.

NOTE: The material included in this training manual can be used as a planning guide for a training program.

A. Planning a system of training is important, but carrying forward this program is even more important.

B. Drills and classroom work, as well as outside training, should be held at least twice a month.

C. Training should be given during regular working hours insofar as possible.

D. No industrial works, warehouse, department store, or similar organization employing labor is too small to arrange for a fire safety organization.

E. Training programs should be adapted to the individual needs of the plant setting up the fire brigade.

VIII. Getting Assistance and Cooperation From Outside Agencies.

A. There should be cooperation between the brigade and the outside fire department at all times.

B. Acquainting the local fire chief and district fire officers with plant conditions, fire hazards, and equipment will assure better fire service if fire does occur.

C. Detailed operational plans should be agreed upon for cooperation between the local fire department and the plant brigade.

D. Most municipal fire departments have fire training programs in operation and are glad to have nearby industrial fire brigades take part in such training or use training facilities.

E. Others who may assist with fire brigade training:

1. State and local educational agencies.
2. National Fire Protection Association.
3. National Board of Fire Underwriters.
4. Insurance Laboratories and Associations.
5. Colleges where fire service training is given.

F. The rapid development of industry constantly brings new fire hazards and the need for new fire extinguishing methods. A well-established training program executed with the assistance of the above agencies will keep the fire brigade up-to-date.

Reference:

Bond, Horatio and Kimball, Warren Y. Industrial Fire Brigades. Boston, Massachusetts: National Fire Protection Association.

PART II: SALVAGE OPERATIONS

I. Definition of Salvage.

Salvage is the saving of property, merchandise, and effects from any emergency arising from fire, water, smoke, heat, elements, or wreckage.

II. Responsibility of Industrial Fire Brigades.

A. The industrial fire brigade, along with the local fire department, should assume the responsibility of salvage operations.

B. Frequently, good salvage operations will enable industry to continue operations with practically no interruption.

III. Value of Human Relations.

A. Management good will.

B. Builds morale and efficiency in firemen.

IV. Salvage Equipment.

A. Salvage covers.

1. Materials used:

a. Treated cotton duck.

b. Rubber-coated duck.

c. Plastic or plastic-coated synthetics.

d. Disposable paper.

2. Sizes of covers.

a. Range in size from 9 x 12 feet to 14 x 18 feet.

b. Most commonly used: 14 x 18 feet.

B. Salvage kits.

NOTE: For convenience, salvage work tools are arranged in kits according to the specific jobs to be done.

1. Roof repair kits.
    a. Hammer hatchet.
    b. Linoleum knife.
    c. Assortment of roofing nails.
    d. Small bundle of woodlaths.
    e. Adequate supply of roofing paper.
2. Mop up kit.
    a. Two detachable mop heads and handles.
    b. Two corn brooms.
    c. Two rubber squeegees.
    d. Two water buckets or tubs.
3. Clean up kit.
    a. Four sponges.
    b. Two scrub brushes.
    c. Two chamois.
    d. Assortment of rags.
    e. Whisk broom.
    f. Odor counteractant.
    g. Two buckets.
4. Woodworking tool kit.
    a. Cross-cut hand saw.
    b. Wrecking bar.
    c. Claw hammer.
    d. Padlock and hasp.
    e. Assortment of nails and screws.
5. Metalworking tool kit.

a. Electricians' pliers.

b. Hack saw.

c. Cold chisel.

d. Pipe wrenches.

e. Crescent wrench.

f. Screw driver.

6. Sprinkler kit.

a. Assortment of sprinkler heads and head wrench.

b. Sprinkler tongs and wedges.

c. Assortment of pipe caps and plugs --
"3/4", "1", "1 1/4", "1 1/2", "2", "2 1/2", "3".

C. Other salvage equipment.

1. The carry-all and its use.

a. A small waterproof carrier or bag.

(1) Made from old or damaged salvage cover.

(2) Size 6 x 6 or 6 x 8 feet.

(3) Handles made by sewing or lacing sash cord around edges.

b. Can be used as a mattress carrier or for other debris removal.

2. Bags of sawdust and their uses.

a. Use white or soft pine sawdust.

(1) Will not stain a finished floor.

(2) Holds together when wet.

b. Used to take up moisture, to build dykes, and to route water out of buildings.

V. Care and Preparation of Salvage Covers.

A. Proper methods for cleaning.

1. Use hose stream.

2. Scrub with broom.

3. If extremely dirty, scrub covers with a washing powder solution, rinse thoroughly.

4. Keep cover wet until cleaned.

B. Proper drying methods.

1. Dry in well-ventilated place.

2. Keep cover dry before folding to prevent mildew and rot.

C. Examining covers.

1. Examine after each use.

2. Three or four men stand side by side and pass cover over head looking for holes.

3. Mark any holes with chalk.

D. Repairing methods.

1. Hand sewing.

2. Machine sewing.

3. Plastic adhesive tape.

4. Waterproof glue and piece of salvage cover material.

E. Placing in service.

1. Salvage covers that have been properly cleaned, dried, examined, and repaired are ready to be folded and placed in service or in stock.

2. Rules for care of covers.

a. Do not throw covers from roofs or windows.

b. Use care when removing covers from sharp projections.

c. Wash and dry as soon as possible after use.

d. When dry, examine for holes and mend before storing.

e. Refold when not used for period of one month.

VI. Methods of Folding Salvage Covers.

NOTE: Methods are identified by number of men required to place cover in service, not number of men required to fold cover. When folding, stress neatness and smoothness of appearance.

A. Two-man salvage cover fold.

1. Stretch cover lengthwise from center and spread on floor.

2. With cover spread on floor, make quarter fold by folding open edges over to folded edge.

3. Fold from open end four times.

B. One-man salvage cover fold.

1. Fold half of cover at a time in two lengthwise folds, edge to center.

2. Fold ends within two inches of center; make three folds for each half of cover.

3. Fold one half over other half.

C. One-man salvage cover roll.

1. Fold lengthwise same as for one-man salvage cover fold.

2. Fold ends over approximately 12 inches.

3. Roll from one end to other.

VII. Methods of Spreading Salvage Covers.

A. Spreading from the two-man fold.

1. Rules for carrying.

a. Either shoulder.

b. Open edge next to neck.

c. Small ropes through grommets of each pair of corners.

2. To assure teamwork efficiency department should standardize on:

a. Shoulder on which to carry cover.

b. Edge of folded cover placed next to neck.

B. The balloon throw (pocketed air floats cover into position and straightens out folds.)

1. Method of throwing.

a. Stretch cover along one side of object to be covered.

b. Drop edge of cover next to object.

c. Make several accordion folds in the hand that is to make the throw.

d. The other hand is placed about midway down the end hem.

e. Pull cover tight between operations.

f. Swing the folded part down, out, and up in one sweeping motion.

g. The folds may be pitched or carried across the object.

h. Cover is floated over object and guided into position.

2. Completing job.

a. Tuck cover around object.

b. Remove any low areas where water might collect.

c. Arrange so water will drain away from object.

C. Spreading from the one-man fold.

1. Carry cover following rules of the two-man fold.

2. Place cover near center of object to be covered.

3. Procedures for spreading cover.

a. Unfold cover at center fold.

b. Unfold each fold one at a time.

c. Standing at one end, grasp one edge in each hand.

d. Snap both hands up and out, opening the cover over end of object.

e. Open other end in same manner.

D. Spreading from the one-man roll.

1. Carry cover following rules of two-man fold.

2. Use of one-man roll.

a. To cover objects.

b. As a floor runner.

3. Spreading cover.

a. Unroll part of cover at one end of object.

b. Place roll on top of object and continue to unroll across the top.

c. Grasping one edge in each hand, snap the cover up and out opening it.

d. Open other end of cover in same manner.

VIII. Arranging Materials to be Covered.

NOTE: Instructor should point out advantages of inspections.

A. Arranging mercantile stock.

1. Skids under perishable stock.

2. Proper shelf construction.

3. When numbers of covers are limited.

a. Cover most valuable stock first.

b. Use wrapping paper, plastic material when available.

B. Covering shelving.

1. Shelves away from wall.

2. Shelves built to the wall.

IX. Removal of Water from Buildings.

A. Methods for routing water from buildings.

1. Natural openings--stairways, elevator shafts, scuppers, etc.

2. Cutting holes in floors.

3. Constructing chutes.

4. Preparing catchalls.

5. Mechanical means.

a. Siphons.

b. Portable pumps.

B. Making chutes.

1. With ladders.

2. On stairway.

C. Procedure for making catchalls.

1. With cover spread on floor, roll two sides approximately three feet.

2. Lay ends of rolls over at a 90° angle.

3. Roll one end three or four feet into tight roll, forming a projected ear with which to lock corners.

4. Roll other end in like manner.

D. Splicing covers.

1. Fold uppermost cover back on itself about 20 inches and lap underneath cover over this fold about 10 inches.

2. Then fold remaining 10 inches of top cover over underneath cover.

3. Entire fold of both covers is then folded down over bottom cover and pressed flat.

X. Restoring the Premises.

NOTE: Leave building and contents as nearly as possible in same condition as before the fire occurred.

A. Remove debris from building--lath, plaster, rags, paper, etc.

B. Use smoke deodorants if possible.

C. Replace contents.

D. Cover roof openings.

E. Restore sprinkler systems.

1. Wet.

2. Dry.

3. Detail watchman if system is not restored.

4. Check closed valves.

XI. Testing Salvage Covers.

A. Tests.

B. Test rack.

C. Lake test.

Reference:

Hudiburg, Everett, and Douglas, R. J., (Comp.) Salvage and Overhaul Practices. Stillwater, Oklahoma: Department of Fire Protection Technology of the Technical Institute, College of Engineering, Oklahoma State University.

PART III: CHEMISTRY OF FIRE

I. Fire Triangle - Its Connection with Fire Prevention, Fire Protection and Fire Fighting.

A. Fuel - normally exists in three physical states.

1. Solid - wood, paper, or coal.

2. Liquid - gasoline, alcohol, or oil.

3. Gas - natural, acetylene, or hydrogen.

B. Oxygen - amounts that support burning.

1. 21 percent - normal content in the air.

2. 16 percent - critical amount for producing flame.

a. Above 16 percent - free burning.

b. Below 16 percent - smouldering or extinguishment.

C. Heat.

1. Most fuels must be heated to the flash point before burning can take place.

2. Ignition temperature - to ignite a combustible material, there must be a high temperature and quantity of heat sufficient to start and continue the burning.

II. Classification of Fires - Definition and Control.

A. Class "A" fires.

1. Definition - fires in ordinary combustible materials such as wood, paper, and cloth.

2. Principle of extinguishment - reduce the temperature of the burning material below the ignition temperature.

EXAMPLE: The "quenching-cooling" effect of sufficient quantities of water or solutions containing large percentages of water.

B. Class "B" fires.

1. Definition - fires in flammable petroleum products or other flammable liquids, greases, etc.
2. Principle of extinguishment - oxygen excluding method is most effective.

C. Class "C" fires.

1. Definition - fires involving energized electrical equipment.
2. Principle of extinguishment - the electrical non-conductivity of the extinguishing agent is of first importance.

D. Class "D" fires.

1. Definition - fires involving metals such as magnesium or titanium.
2. Principle of extinguishment - apply specially designed agents to blanket or smother.

References:

Bond, Horatio and Kimball, Warren Y., Industrial Fire Brigades. Boston, Massachusetts: National Fire Protection Association.

The National Fire Codes, Volume I, Flammable Liquids and Gases. Boston, Massachusetts.

Department of Community Colleges, Fire Service Training Program.

PART IV: PORTABLE FIRE EXTINGUISHERS

I. Definition.

Portable fire extinguishers are appliances which have a limited supply of fire extinguishing potential.

II. Fire Triangle - its connection with fire prevention, fire protection, and fire fighting.

NOTE: Instructor should review characteristics of the fire triangle under Part III of this outline.

III. Classification of Fires and Principles of Extinguishment.

NOTE: Instructor should review definitions of fire classes as given in Part III of this outline.

A. Class "A" Fires - reduce the temperature of the burning material below the ignition temperature.

EXAMPLE: The "quenching-cooling" effect of sufficient quantities of water or solutions containing large percentages of water.

B. Class "B" Fires - oxygen excluding or diluting method is most effective.

C. Class "C" Fires - the electrical nonconductivity of the extinguishing agent is of first importance.

D. Class "D" Fires - apply specially designed agents to blanket or smother.

IV. Classification of Fire Extinguishers.

Extinguishers are classified in units of protection according to their relative extinguishing potential and to the fire conditions for which they must be used.

A. Method of classification by Underwriters' Laboratories, Inc.

1. Numeral - indicates extinguishing potential.

2. Letter - indicates class of fire for which extinguisher is best suited.

B. Classes of extinguishers.

1. Class "A" - for ordinary combustibles.

2. Class "B" - for flammable products.

3. Class "C" - for electrical fires.

4. Class "D" - for metals.

V. Distribution of Extinguisher Units.

NOTE: Units described here are for Class "A" extinguishers - the most commonly used for ordinary combustibles. Other classes of extinguishers should be provided wherever necessary.

A. Light hazard occupancies.

1. Examples.

a. Office buildings.

b. Schools.

c. Public buildings.

2. Protection requirements of light hazard occupancies.

a. One unit of Class "A" protection for every 2,500 square feet of floor space.

b. Placed so that a person will not have to travel more than 100 feet to reach.

B. Ordinary hazard occupancy.

1. Examples.

a. Department stores.

b. Warehouses.

c. Manufacturing buildings of average hazard.

2. Requirements of ordinary hazard occupancy.

a. One unit of Class "A" protection for every 1,250 square feet of floor space.

b. Placed so that a person will not have to travel more than 50 feet to reach.

C. Extra hazard occupancy.

1. Examples.

a. Woodworking shop.

b. Spray painting.

c. Dipping.

2. Requirements of extra hazard occupancy - at the discretion of the authority having jurisdiction, extinguishers suitable for the extra hazard shall be provided in addition to those specified for ordinary hazard occupancies.

VI. Using Portable Extinguishers.

A. Chemical solution (soda-acid) extinguishers.

1. Operating principle.

a. Absorbs heat from burning material.

b. Chemicals used to expel liquid - bicarbonate of soda and sulfuric acid. (The reaction of the two chemicals provides pressure which expels the liquid).

2. Classification and suitability.

a. The 2½-gallon size is classified 2-A.

b. For Class "A" Fires.

3. Servicing.

a. Recharge annually or after use.

b. Do not use anti-freeze or wetting agents.

c. Have extinguisher hydrostatically tested every five years.

4. Operation and range.

   a. Invert to mix chemicals.

   b. Range of 30-40 feet.

B. Water-expellant - gas-operated extinguishers.

1. Operating principle.

   a. Absorbs heat.

   b. Water is expelled by carbon dioxide, nitrogen, or compressed air.

2. Classification and suitability.

   a. The 2½-gallon size is classified 2-A.

   b. For Class "A" Fires.

3. Servicing.

   a. Recharge after use.

   b. Check annually.

   c. Have extinguishers hydrostatically tested every five years.

4. Operation and range.

   a. Usually gas is released by inverting and striking the plunger in the ring cap on the floor.

   b. Range of 30-40 feet.

   NOTE: If other methods are used to release gas, instructions on extinguisher will specify.

C. Loaded stream solution.

1. Operating principle.

   a. Contains alkali metal salts which absorb heat and reduce oxidation.

   b. Expelled by carbon dioxide or nitrogen.

   NOTE: Freezing point is minus 40° F.

2. Classification and suitability.

a. The 2½-gallon size is Class A-1 and B-2.

b. For Class "A" and Class "B" fires.

3. Servicing.

a. Follow manufacturers' instructions as printed on extinguisher.

b. Check immediately following use.

c. Have extinguisher hydrostatically tested every five years.

4. Operation and range.

a. Invert and strike the plunger in the ring cap on the floor.

b. Range of 30-40 feet.

D. Foam extinguishers.

1. Operating principle.

a. Blankets fire, being heavier than air.

b. Chemicals used.

(1) Inner container - aluminum sulfate.

(2) Outer container - bicarbonate of soda plus a foam stabilizing agent.

c. When chemicals mix, foam and pressure are produced for expelling.

2. Classification and suitability.

a. The 2½-gallon size is classified 2-A and 4-B.

b. Suitable for Class "A" and Class "B" fires.

3. Servicing.

a. Recharge annually or after use.

b. Use no anti-freeze solution or wetting agents.

c. Have extinguisher hydrostatically tested every five years.

4. Operation and range.

a. Invert to mix chemicals.

b. Range of 30-40 feet.

E. Carbon dioxide extinguishers.

1. Operating principle.

a. Blankets fire, restricting oxygen.

b. Carbon dioxide is an inert gas which will not support combustion.

2. Classification and suitability.

a. These extinguishers are classified from 1 BC to 12 BC depending upon the size.

b. For Class "B" or Class "C" fires.

3. Servicing.

a. Refill immediately after use even though only partially discharged.

b. Inspect and weigh annually.

NOTE: If extinguisher shows a loss of 10 percent or more of the rated capacity stamped upon it, it should be recharged and the valve repaired.

c. Have extinguisher hydrostatically tested every 12 years.

4. Operation and range.

a. Remove locking pin. Pull trigger, squeeze grip or twist handle to open valve.

b. Range of 3-8 feet.

F. Dry chemical extinguishers.

1. Operating principle.

a. Chemicals blanket fire, restricting oxygen.

b. Consists mainly of bicarbonate of soda.

c. Expelled by stored pressure - carbon dioxide, nitrogen, or compressed air.

2. Classification and suitability.

a. These extinguishers are classified from 4 BC to 40 BC.

b. For Class "B" or Class "C" fires.

c. Best suited for Class "B" fires.

3. Servicing.

a. Refill after each use.

b. Inspect and check annually.

c. Use only those chemicals recommended by the manufacturer.

d. Have extinguisher hydrostatically tested every ten years.

4. Operation and range.

a. Operate according to instructions printed on the extinguisher.

b. Range of 5-20 feet.

G. Vaporizing liquid extinguisher.

1. Operating principle.

a. Blankets fire, restricting oxygen.

b. Expel by manually operating pump gun or stored pressure.

c. Liquid rapidly evaporates and forms a smothering vapor as it is sprayed upon a fire.

NOTE: Carbon tetrachloride has an anesthetic effect. If subjected to high temperatures, it may decompose to some extent, forming other gases including hydrocholric acid and phosgene. The possible toxic action of carbon tetrachloride depends upon the conditions in which it is used.

2. Classification and suitability.

a. These extinguishers are classified ½ BC (one and two quart size).

b. Suitable for Class "B" and Class "C" Fires.

c. Effective on incipient fires in electrical equipment where a non-conducting extinguishing agent is necessary.

3. Servicing.

a. Keep extinguishers full at all times.

b. Refill immediately after use.

c. Use no water in this extinguisher, as even a small percent causes corrosion.

d. Have extinguisher hydrostatically tested every five years.

4. Operation and range.

a. Expel agent by manually operated pump gun or by stored pressure.

b. Operate according to instructions printed on extinguisher.

c. Range of 20-30 feet.

VII. Special Extinguishing Agents.

A. Wetting agents.

1. Chemical compound that reduces the surface tension of plain water and increases penetrating ability.

2. Cannot be used in extinguishers that use chemical reaction for discharge.

B. Special powder.

1. For use on metal fires (magnesium, titanium).

2. Compose chiefly of graphite or sodium chloride.

3. Not listed as approved extinguishers.

References:

International Fire Service Training Association Manuals:

Forcible Entry, Rope and Portable Extinguisher Practices

Fire Service Practices for Volunteer Fire Departments

Published by: The Department of Fire Protection Technology
Oklahoma State University
Stillwater, Oklahoma

PART V: BREATHING EQUIPMENT AND PROTECTIVE CLOTHING

I. Purpose of Breathing Equipment.

A. Aids rescue in areas:

1. Filled with smoke and noxious gases.

2. That have an oxygen deficiency.

B. Aids in fire fighting.

1. Speeds attach - rapid entry.

2. Enables fire fighters to locate fire.

C. Breathing equipment offers no protection against fire, heat, or skin irritants.

1. When it gets too hot to stay in a building without breathing equipment, it is too hot to remain in the building with equipment.

2. Breathing equipment does not protect against gases that attack the skin, such as hydrocyanic acid.

II. Types of Breathing Equipment.

A. Self-contained equipment.

1. Oxygen-generating.

2. Demand regulator.

a. Air.

b. Oxygen.

3. Oxygen-rebreathing.

B. Filter.

C. Supplied-air type.

III. Self-contained Oxygen-generating Breathing Equipment "Chemox" (10 and 15 minutes).

A. Parts.

1. Facepiece.
    a. Lens.
    b. Head harness.
    c. Rubber mouthpiece.
    d. Speaking diaphragm.
2. Facepiece valve assembly.
    a. Starter valve (O. B. A. only).
    b. Inhalation valve.
    c. Exhalation valve.
    d. Relief valve.
3. Breathing tubes.
    a. Inhalation.
    b. Exhalation.
4. Breathing bag.
    a. Reservoir for oxygen.
    b. Cooling medium for heated air.
5. Canister.
    a. Contains chemicals that purify exhaled breath by absorbing carbon dioxide. Generates oxygen.
    b. Life of canister.
6. Frame.
    a. Supports breathing bags.
    b. Supports canister holder.
7. Canister holder.
    a. Hinged bail.
    b. Handwheel.

8. Mechanical timer.

9. Harness.

B. Procedures for donning the "Chemox".

1. Before donning, unfasten and straighten all harness straps.

2. Pick up equipment, one hand on central casting and other on D-ring assembly; slip harness over head.

3. Grasp harness strap, bring end of strap beneath armpit and snap into metal D-ring located on top side of the breastplate. Repeat procedure for opposite strap.

4. Adjust equipment on body by metal slides on harness straps. Position on body should be such that when facepiece is put on, breathing tubes will permit the greatest freedom of movement of the head.

5. Attach waist strap to the small D-rings on each lower side corner of breastplate and adjust to hold equipment snugly to body.

6. To place canister in equipment, remove metal protective cap by pulling the metal strip straight out and then straight back across the top of the cap.

7. Remove cardboard and metal discs.

8. Swing bail outward to permit canister to enter the canister guard.

9. Insert canister into canister guard with the opening upward and with the "bulged" side away from the wearer. (Insert canister sufficiently to puncture copper foil.)

10. Swing bail back under canister and turn the handwheel clockwise until it is held firmly in place. (This action seals against entrance of outside air and forms a closed circuit between facepiece and breathing bag.)
11. Before donning facepiece, loosen head harness straps and hold facepiece and straps by grasping upper sides with both hands.
12. Place chin into small pocket at bottom of facepiece and fit facepiece to temples and forehead. Release facepiece with both hands holding secure to harness and pull harness over top of head.
13. Tighten chin straps first by pulling out and back on tabs.
14. Tighten temple straps in same manner.
15. Tighten top straps last and in same manner.
16. With facepiece in position, grasp both breathing tubes with right hand, squeeze tightly, depress starter valve and inhale, then release starter valve and tubes and exhale into equipment. Repeat this for several complete respirations to inflate breathing bag and start chemical action in canister. Always inflate bag by above procedure before using the equipment, since such procedure is absolutely necessary to start action of the chemical. (M. S. A. has introduced the 30-minute self-starter "Chemox" unit.)
17. After inflating the bag, turn pointer on timer dial clockwise to number 30. As equipment is used, the pointer will return to zero at which point a bell will sound. If there has been no noticeable resistance to breathing, reset pointer on timer for

an additional 15 minutes' work. When the timer bell sounds after canister has been in use 30 or 45 minutes, or when it becomes an effort to exhale, immediately return to fresh air. (Under extreme exertion, time may be reduced.)

18. If excessive pressure should develop, open release valve allowing some of the oxygen moisture to escape.

19. As a precaution, set timer under maximum time to allow adequate time for return to fresh air.

C. Rules for maintaining the "Chemox".

1. Inspect thoroughly after each use or at least weekly to make sure there has been no deterioration or injury to the bags, facepiece, breathing tubes or harness.

2. Air tightness test.

a. Don facepiece.

b. With facepiece in position, grasp both breathing tubes with right hand, squeeze tightly and inhale deeply. Facepiece should collapse around the face.

3. Dispose of partially filled canister as it cannot be reused.

4. Remove facepiece and breathing tubes from apparatus; wash in warm soapy water; disinfect with methyl alcohol or two percent lysol.

5. Place in case properly with all straps fully extended.

D. Precautions to be observed with the "Chemox".

1. Not recommended for use in atmosphere laden with petroleum vapor.

2. Proper disposal of canister.

IV. Self-contained Demand Regulator Breathing Equipment.

A. The demand regulator type provides eye and respiratory protection and is limited to the amount of air and/or oxygen carried in the supply cylinder (30 minutes).

B. Parts.

1. Air or oxygen cylinder.
   a. Container for holding the supply of pure air or oxygen.
   b. A fully charged cylinder should contain 1,980 p.s.i. (1,800 plus 10 percent).
2. Cylinder valve - controls the supply of air or oxygen from cylinder to the regulator shutoff valve.
3. Regulator hose.
   a. Connects the cylinder to the regulator.
   b. Ruggedly built of metal reinforced neophrene.
4. Regulator.
   a. A reducing valve.
   b. It lowers the air under pressure with air reaching the facepiece at low pressure as the breathing of the wearer demands it.
5. Regulator shutoff valve.
   a. Yellow or green knob opposite bypass valve where regulator and regulator hose connect.
   b. Provided to shut off the regulator in event of failure.
   c. Should always be fully open and locked open.
   d. Close it only after emergency bypass valve has been opened.
6. Emergency bypass valve.
   a. Red knob opposite the regulator shutoff valve.

b. Provided to give a continuous flow of air to the facepiece, bypassing the regulator shutoff valve.

c. Use when regulator valve is closed or fails to function.

d. Adjust bypass valve to allow flow of air to suit user's requirements.

7. Facepiece and corrugated hose.

a. Rubber face mask with non-fogging laminated safety glass lens and attached corrugated rubber hose.

b. Provides air to the wearer.

c. M. S. A. and Scott supply a speaking diaphragm.

8. Exhalation valve.

a. Diaphragm valve located on the facepiece through which exhaled air passes to the outside atmosphere.

b. Also permits conversation at short range.

9. Safety chain or lever.

a. Attached to cylinder valve assembly.

b. Snap-on chain or lever fastens into cylinder valve handwheel to keep valve from being turned off accidentally.

10. Regulator pressure gauge.

a. Attached to regulator in plain view of wearer of mask.

b. Shows exact pressure in air cylinder.

c. Another gauge (cylinder pressure gauge) is located on the cylinder valve assembly and serves the same purpose.

11. Quick-connect coupling.

a. Attached to corrugated breathing tube for easy immediate connection to regulator.

b. A good connection is assured when tightened with fingers.

C. Procedures for donning the demand regulator.

NOTE: Instructions are for back-strapped model with side straps fastened, chest and belly strap opened. Instructors should use procedures applicable to each situation.

1. Open case.
2. Open cylinder valve three full turns.
3. Remove facepiece.
4. Lift from case, place cylinder with backplate away from you, cylinder valve down.
5. Grasp two shoulder straps near backplate, palms down.
6. Lift up and to left as if putting on a coat.
7. Fasten chest and belly straps.
8. Adjust side straps.
9. Put facepiece on chin first, tighten head harness bottom to top.
10. Test for fitness.
11. Attach quick-connect coupling.

D. Maintenance of demand regulator.

1. Fill tanks with compressed air (full 1,980 p.s.i., 40.3 cubic feet).

a. Refill from manifold tanks.
b. High pressure compressor.

} slowly to prevent overheating

NOTE: Oxygen cylinders can be supplied and filled by manufacturer or representative. Federal law requires hydrostatic test every five years.

2. Wash entire unit in warm soapy water.

3. Disinfect facepiece and breathing tube with methyl alcohol or two percent lysol.
4. Check for leaks with soapy water.
5. Be sure all connections are tight.
6. Unit should be protected from sun, dust, steam, and hot air.
7. Be especially careful of demand regulator.
8. Air cylinder should not be subjected to sudden pressure increase.
9. Place in case properly with all straps fully extended.
10. Place facepiece in case with harness straps fully extended.

E. Precautions to be observed with demand regulator.

1. Do not use oil or grease on this breathing apparatus.
2. If automatic demand valve becomes inoperative, open bypass valve (red) to escape to fresh air. Close shutoff valve (yellow or green).
3. Should diaphragm and housing be blown off, use hand as housing, operate red valve and get to fresh air.
4. Should safety valve open, it indicates excessive pressure in regulator. Operate emergency bypass valve (red) and get to fresh air.
5. When hand on regulator pressure gauge drops to warning sector (300 p.s.i., approximately four minutes remaining), start for fresh air.
6. Close valves firmly with fingers; do not force.

7. IMPORTANT - Make sure that the equipment is clean and dry before placing in the case for storage. In drying the equipment, place the regulator flat with the diaphragm cover downward so that water can drain from under the cover. If water has entered the regulator pressure gauge, unscrew the bezel, remove the gauge glass, rinse with fresh water and allow to dry out. After reassembly, apply gasket shellac or similar compound to the underside of the gauge assembly to keep water out. Gauges are water resistant but may require additional compound after being in use for a period of time.

8. Will not protect against poisoning through skin.

V. Self-contained Oxygen Rebreathing Equipment.

A. Parts.

1. Oxygen cylinder.
2. Bypass control valve.
3. Bypass line.
4. Main control valve.
5. Gauge valve.
6. High pressure reducing valve.
7. Pressure gauge.
8. Safety whistle.
9. Cardoxide.
10. Breathing bag.
11. Bumper plate.
12. Admission valve.
13. Cooling space.

14. Breathing tubes.

15. Facepiece.

    a. Inhalation valve.

    b. Exhalation valve.

    c. Mouthpiece.

B. Rules for donning the oxygen rebreathing type.

1. Before donning, unfasten and straighten all harness straps.

2. Standing behind the case, grasp the two shoulder harness straps just below the adjustment buckles permitting the harness to cross over the back of each hand.

3. Elevate the equipment about shoulder high, allowing the facepiece and tubes to hang in front of breathing bag, and work the elbows through the loops formed by the straps which are snapped to D-rings on each side.

4. Raise both hands over top of head and place them well down on the nape of the neck.

5. Release shoulder straps and adjust equipment into position. Equipment is secured in place by fastening waist strap.

6. Apply facepiece and open oxygen cylinder valve one turn. (This permits a flow of oxygen to the admission valve and breathing bag.)

C. Maintenance of oxygen rebreathing type.

1. Inspect thoroughly after each use or at least weekly to make sure there has been no deterioration or injury to the breathing bag, facepiece, breathing tubes or harness.

2. Check cylinder pressure. If the pressure is below 125 atmospheres, the cylinder should be recharged.

3. A new charge of cardoxide should be put in the regenerator each time a new cylinder of oxygen is used.

4. Test oxygen cylinder for leaks.

VI. Filter-type Breathing Equipment.

A. Parts.

1. Canister (colors).

a. Contents.

b. Life of canister.

2. Harness.

3. Automatic timer.

4. Breathing tube.

5. Facepiece.

a. Lens.

b. Head harness.

c. Exhalation valve.

d. Speaking diaphragm.

6. Windowcater canister.

NOTE: Item is now being supplied by the manufacturer.

a. Two color panels visible through window of canister.

b. This provides positive indication when canister is no longer effective against carbon monoxide.

c. Colors of panels.

(1) Left panel is dark blue.

(2) Right panel is lighter blue than left panel.

(3) When left panel turns to a matching lighter blue, it is a positive indication that enough moisture has

penetrated the hopcolite to render it ineffective against carbon monoxide.

(4) Continued use causes indicator panel to turn pink.

(5) CAUTION - Do not use canister if colors match or if indicator panel is pink.

d. Life of canister.

(1) No longer than two hours with one-year time limit.

(2) Canister to be discarded when colors match.

7. Advantages of the external check valve.

a. Eliminates use of automatic timer.

b. Threaded at both ends to permit positive connection between canister and breathing tube.

c. Keeps exhaled air from entering canister.

d. Provides an effective seal against entry of moisture into the top of the canister during use or storage.

e. Closes automatically after inhalation regardless of the position of the canister.

f. Guards the canister against moisture penetration when facepiece and tube are being cleaned.

8. Conversion kit.

a. Old type all-service masks can be converted to the new type by use of a conversion kit obtained from the manufacturer.

b. Items are now being supplied by the manufacturer.

B. Procedure for donning the filter type mask.

1. Remove equipment from case and adjust neck harness for size.

2. Place neck harness over head and around the back of the neck and place canister on the chest.
3. Remove adhesive seal from canister intake valve.
4. Apply facepiece.
5. Test for leaks by applying palm of hand over opening in bottom of canister.
6. Adjust and fasten chest strap.

C. Maintenance.

1. Inspect thoroughly after each use or at least weekly to make sure that there has been no deterioration or injury to facepiece, breathing tube or harness.
2. Replace gasket with each new canister.

D. Precautions to be observed with the filter type mask.

1. Does not protect the wearer in atmosphere deficient in oxygen.
2. Canisters have shelf life of six months to one year. (Give reasons.)
3. Date canisters when received and also when put in service.
4. Designed to protect against carbon monoxide not to exceed two percent by volume.
5. Watch for lens fogging.
6. Watch for resistance to breathing. (<u>This is operator's best timer</u>.)
7. Watch for physical symptoms of canister failure, such as headache, nausea, and dizziness.
8. <u>Do not use in basement fires</u>.
9. Timer not dependable.

10. Will not protect against skin poisoning.

11. <u>If in doubt, use self-contained apparatus</u>.

VII. Supplied Air-type Breathing Equipment.

A. This type of equipment is not designed for fire fighting, but can be used during certain kinds of rescue. The supplied air protective breathing equipment is commonly referred to as "hose masks".

B. They consist of a facepiece, up to 150 feet of reinforced hose and a hand-operated or electrically-operated centrifugal blower. Hose masks are used to furnish fresh air to the workman who must enter and work in highly concentrated gaseous or oxygen deficient atmospheres within a short distance from fresh air in places such as tank cars, oil storage tanks, sewers, etc. Units are available for supplying as many as four men. Fresh air is taken from the outside and blown through the hose attached to the mask facepiece. The wearer is restricted in his travels by the hose. As long as the blower, which must be operated by an attendant, is in uncontaminated air, the wearer is dependent of the atmosphere surrounding him.

C. One hazard of this type of mask to which the others are not subject is that a beam or other heavy material may drop on the hose, cutting it or shutting off the air. There is no limit on the length of time it can be used.

VIII. Protective Clothing.

A. Protective clothing for each member of the fire brigade is desirable and should consist of the following.

1. Helmet - with chin strap and ear covers.

2. Gloves.

3. Rubber boots (steel insoles).

4. Coat (rubber or canvas).

B. It should be a rule of the fire brigade that each member:

1. Be responsible at all times for his protective clothing.

2. Wear his protective clothing during all emergencies.

References:

International Fire Service Training Association Manuals:

Rescue Practices

Protective Breathing Equipment

Fire Service Practices for Volunteer Fire Departments

Published by: The Department of Fire Protection Technology
Oklahoma State University
Stillwater, Oklahoma

PART VI: LADDER PRACTICES

I. Introduction.

A. Wood ladders.

1. Solid beam construction.

2. Trussed beam construction.

3. Types of wood used.

a. Douglas fir for beams.

b. White ash or hickory for rungs.

B. Metal ladders.

1. Aluminum alloy - hand-operated ladders.

2. Aluminum alloy - power-operated ladders.

3. Steel alloy - power-operated ladders.

4. Construction of metal ladders.

a. Heat treated aluminum alloy or steel alloy.

b. Riveted or welded.

5. Reasons for use of metal ladders.

a. Lighter weight - 10 percent to 35 percent lighter than wood.

b. Greater strength - greater safety factor.

c. Reliable inspection - less maintenance.

C. Trade terms applying to ladders and their parts.

NOTE: Instructor should explain terms.

1. Terms applying to ladders.

a. Single wall ladder or straight wall ladder.

b. Extension ladder.

c. Extension ladder with poles.

d. Tormentor poles or stay poles.

e. Main ladder or bed ladder.

f. Fly ladder or extension.

2. Terms applying to parts of ladders.

a. Heel, foot, or butt.

b. Heel plate.

c. Top or tip.

d. Beam.

e. Truss.

f. Rungs.

g. Spurs or spears.

h. Halyard line or fly rope.

i. Pulley.

j. Pawl or dog.

k. Truss blocks.

l. Braces.

m. Steps.

n. Guides.

o. Tie rods.

p. Beam bolts.

q. Halyard anchor.

r. Tormentor toggle.

s. Ladder protection plates.

D. Types of ladders.

1. Roof ladder.

2. Attic ladder.

a. Folding.

b. Baby extension.

3. A-frame ladder.

4. Single wall ladder.

5. Extension ladder.

6. Extension ladder with poles.

II. Handling Ladders.

A. Placing of ladders.

1. Desired angle of 75^{o} with ground.

2. Butt of ladder should be out from base of building one-fourth the length of ladder being used, or

3. Butt of ladder should be out from base of building one-fifth the length of ladder being used plus two feet.

B. Procedures for climbing ladders.

1. Safety precautions.

a. Check placing of ladder.

b. Check heels.

c. Observe top of ladder - rests firmly in proper position.

d. Check pawls or dogs - properly set over rungs.

e. Check tormentor poles.

2. Body position while climbing.

a. Smoothly and rhythmically - bouncing to a minimum.

b. Body perpendicular to the ground.

c. Eyes front - occasionally glancing at top.

d. Hands grasping convenient rung.

NOTE: Instructor should stress form rather than speed, and have students practice climbing both with and without objects in one hand.

3. Passing on the ladder.

   a. Man going up gives command, "passing on right".

   b. Person working on ladder moves left as far as safety allows.

C. Working from a ladder.

   1. Use safety belt.

   2. Use leg lock.

   3. Anchor top of ladder.

   4. Heel or hold ladder.

   5. Observe margin of safety by providing one man for every 10 feet.

D. Procedure for handling the roof ladder.

   1. Carrying the ladder.

      a. Crouch at middle of ladder on either side, face opposite the direction of travel.

      b. Lift ladder shoulder high, turn toward ladder, insert arm between beams and place upper beam on shoulder.

      c. Steady ladder with both hands and lower the hooks for carrying.

   2. Placing into position on a roof.

      a. Hooks should be opened while ladder is at ground level.

      b. Turn hooks away during climb up the ladder.

      c. On approaching eave of roof, tie in on ladder and turn the hooks of the roof ladder downward to roof.

      d. Use hook as skid and slide ladder up over peak of roof.

   3. Raising ladder to wall.

      a. When roof ladder is used as a short wall ladder, leave hooks closed.

      b. Place heels of ladder against building with ladder flat.

c. Swing under top end of the ladder and with arms extended, advance hand over hand down rungs until ladder is flat against the wall.

d. Then step to one side and carry the heel away from the building to a climbing position.

E. Handling the attic ladder.

1. The folding attic ladder (pole ladder).

a. Carry in the folded position so that ladder can be placed into small, confined areas before it is opened for use.

(1) Wooden attic ladder - about four feet square when folded.

(2) Metal attic ladder - about two feet square when folded.

b. To open the ladder, pull outward and downward on each beam until each beam rests firmly upon the floor with the rungs exposed.

NOTE: Instructor should point out the construction feature of the rungs hinged to the beams which permits the open ladder to move from side to side when a force is applied.

With the top end of ladder placed through the ceiling opening and the bottom end resting upon the floor, side movement is reduced to a minimum. Some folding ladders are provided with a lock brace that may be set to reduce side movement.

2. The baby extension ladder and its use.

a. The baby extension ladder may be used as an attic ladder also.

b. It may stand upright in almost any doorway.

c. Can be placed into a vertical position directly below attic opening.

d. Fly section can be extended up through attic opening to desired height.

F. The extension ladder.

1. Sizes.

a. Two sections, commonly 24 feet.

b. Three sections, commonly 35 feet.

2. Executing the two-man carry.

a. With ladder flat on ground, both men take position--one at each end on the same side of ladder and facing opposite the direction they are to travel. From a crouching position, they grasp a convenient rung at the far side of the ladder.

b. Both men lift ladder shoulder high, turn toward ladder, insert free arm between beams and place upper beam on their shoulders.

c. The ladder can be removed from the rack to the carrying position without placing it flat on the ground.

NOTE: Extension ladders may be raised either parallel to the building or at right angles to the building. Relationship of ladder to building does not alter raise except the ladder will need to be pivoted when it is raised parallel to the building.

3. Executing the two-man flat raise.

NOTE: It is the responsibility of the lead-off man to select the location for the raise and to space the heel of the ladder to proper distance from the building.

a. The lead-off or heel man removes ladder from shoulder and places it flat. (The ladder is removed from the beam man's shoulder in the same movement.) Then facing the beam man, he heels the ladder with the toe of each foot on each beam or

on the bottom rung. From a crouching position, the heel man grasps a convenient rung with both hands and leans back so his weight will help raise the ladder.

b. The beam man swings under ladder after heel man is in position. With arms extended, he advances hand over hand, down the rungs toward the heel man until the ladder is in a vertical position.

c. Both men face each other through ladder and pivot ladder if necessary. Heel man holds ladder upright while beam man raises fly section. Beam man places one foot on bottom rung and both men lower ladder to building.

NOTE: Fire fighters must reverse these operations to lower the ladder.

4. Executing the two-man beam raise.

NOTE: It is the responsibility of the lead-off man to select the location for the raise and to space the heel of the ladder to proper distance from the building.

a. The lead-off man (heel man) removes ladder from shoulder and places lower beam at selected place. Placing his inside foot upon lower beam at heel, he turns his body toward ladder, and grasps upper beam with both hands. The other leg acts as a counterweight and balance for the heel man.

b. The beam man removes ladder from shoulder and swings under the lower beam with extended arms. He advances then, hand over hand, down beam toward heel man until ladder is in a vertical position.

c. Both men face each other through ladder and pivot ladder if necessary. The heel man holds ladder upright while

beam man raises fly section. The beam man then places one foot on the bottom rung and both men lower ladder to building.

NOTE: Fire fighters must reverse these operations to lower the ladder.

G. Handling single wall ladders up to 18 feet.

1. One-man carry.

2. One-man raise and lower.

3. Two-man carry.

4. Two-man beam raise and lower.

5. Two-man flat raise and lower.

H. Handling medium length extension ladders (25-40 feet).

1. Four-man carry.

2. Four-man raise and lower.

I. Handling extension ladders with poles (35-60 feet).

1. Six-man carry.

2. Six-man raise and lower.

NOTE: Instructor should make job breakdown for each job in preceding sections I, J, and K.

III. Special Ladder Operations.

A. Special ladder carries.

1. Vertical position - carrying a ladder in a vertical position should be limited to short distances such as alignment of ladders to a building or moving the ladder to an adjacent window.

2. Overhead carry - for carrying a ladder through narrow spaces.

a. Overhead carry involves the shifting of men from their normal position at the side of the ladder to a position underneath the ladder.

b. In this position the men straighten their arms and carry the ladder overhead.

B. The factory raise - a means by which victims trapped on different floors can be rescued by one ladder.

1. This rescue practice can be accomplished by raising an extension ladder close to the building and in line with a row of windows. The heel man and the beam man anchor base of ladder.

2. With the ladder in this position, trapped victims at the lower windows can climb to the ground on the inside of the ladder. Victims from upper floor windows can climb down the outside of the ladder.

3. Bridging with ladders - a means by which fire fighters can travel from one object to another when separated by an open space.

a. One method of placing a wall ladder across a span is for two men to pick the ladder up by beams near end and serve as a fulcrum. A third man at the end supplies the force.

b. Trussed ladders should be placed across the span with truss side down so that truss will be under tension instead of under compression.

IV. Care of Ladders.

A. Inspecting ladders.

1. Purpose - ladders are subjected to considerable abuse. To assure their dependability, they should be inspected regularly.

2. How often.

a. Once each year - thoroughly.

b. Weekly clean up period - constant lookout.

c. After each use - constant lookout.

3. What to look for.

a. Cracked or splintered trusses and beams.

b. Bruised or marred rungs.

c. Worn or splintered tormentor poles.

d. Loose rungs.

e. Loose bolts.

f. Worn halyard.

g. Compression failure.

B. Overhauling ladders.

1. Overhaul periodically.

2. Method for overhauling.

a. Remove all old varnish.

b. Sand all surfaces.

c. Apply two coats of sealer.

d. Apply two coats of spar varnish.

C. Testing ladders.

1. Test annually or whenever visual inspection indicates need.

2. Procedure for testing.

a. Check for tightness.

(1) Attempt to twist rungs by hand.

(2) Inspect bolts and rivets.

b. Check welds for defects.

c. Inspect rails for cracks, splinters, breaks, gouges, checks, wavy condition.

NOTE: If discoloration or slight deformation in the ladder is noted prior to testing, it is not necessarily an indication that the ladder is unsafe. Test ladder to determine safety.

References:

International Fire Service Training Association Manuals:

Ladder Practices

Fire Service Practices for Volunteer Fire Departments

Fire Department Equipment: Ladders in Fire Service Training

Published by: The Department of Fire Protection Technology
Oklahoma State University
Stillwater, Oklahoma

PART VII: HANDLING FIRE HOSE

I. History of Fire Hose.

A. The bucket brigade - before the introduction of fire hose, water was moved by passing buckets of water down a line of organized fire fighters.

B. Steps in fire hose advancement.

1. Leather hose - first flexible hose.

2. Canvas hose - woven from flax.

3. Cotton jacket - lined with rubber.

II. Types of Fire Hose Commonly Used.

A. Cotton jacket, rubber-lined hose.

B. Rubber-lined, rubber-covered hose.

1. Booster.

2. Hard suction.

C. Unlined linen hose.

D. Hose in which synthetic materials are used.

III. Sizes of Fire Hose.

A. Rubber-lined, rubber-covered hose.

1. Booster lines - three quarters of an inch, one inch.

2. Hard suction - two and one-half inches, three inches, four inches, four and one-half inches, five inches, and six inches.

B. Cotton jacket, rubber-lined hose - one inch, one and one-half inches, two and one-half inches, three inches, and three and one-half inches (single or double jacket).

C. Hose in which synthetic materials are used - made in same sizes as cotton jacket, rubber-lined hose plus two inches and two and three-quarter inches.

IV. Care of Fire Hose.

A. Common mechanical injuries.

1. Worn places and rips.

2. Abrasions.

3. Crushed or damaged couplings.

4. Cracked inner linings.

B. Methods of preventing mechanical injury.

1. Avoid laying hose over rough sharp corners.

2. Provide warning lights and use hose bridges in traffic lanes.

3. Avoid shutting the nozzle abruptly.

4. Avoid dropping couplings on concrete.

5. Do not permit vehicles to run over fire hose.

6. Change positions of bends in hose when reloading.

7. Provide chafing blocks to prevent abrasion near pumper or pumps.

8. Avoid excessive pressure.

C. Effects of excessive or prolonged heat.

1. Contact with fire will weaken cotton fabric and dry rubber lining.

2. Hose hung in drying tower for long periods of time in high temperature will dry inner linings.

D. Prevention of damage by prolonged heat.

1. Protect hose from excessive heat or fire when possible.

2. Remove hose from drying facility as soon as it is dry. Use moderate temperature for drying.

3. Keep the outside of the hose dry.

4. Run water through hose that has not been used for some time to prolong its life.

E. Mildew and mold.

1. May occur on cotton or cotton-dacron jackets when moisture is allowed to remain on the outer surfaces for a long period.

2. Will cause rot and decay of fabric.

F. Prevention of mildew and mold.

1. Remove all wet hose after a fire and replace with dry hose.

2. Remove all hose from apparatus or racks every 30 days so that it may be swept and inspected.

G. Chemical contacts.

1. Gasoline can penetrate hose jacket and damage rubber lining.

2. Acid may seriously injure cotton jacket.

H. Prevention of chemical contacts.

1. Thoroughly scrub and brush all traces of acid contacts with soda solution. The soda neutralizes the acids.

2. Guard against spilling gasoline on hose when filling supply tanks.

3. Remove hose from apparatus or racks periodically and wash with fresh water and dry thoroughly.

4. If suspicion of injury exists, hose should be properly tested.

I. Washing and drying procedures.

1. Washing.

a. After using hose at fires, brush dirt off.

b. If dirt cannot be removed by brushing, the hose may be washed and scrubbed with plain water.

c. When a hose has been exposed to oil, wash it with a mild soap or approved detergent and rinse properly.

2. Drying.

a. Drying should not be done:

(1) In the sun.

(2) On concrete roadways.

(3) On sidewalks.

b. If available, use:

(1) Hose drying tower.

(2) Hose drying rack.

(3) Cabinet type hose dryer.

V. Fire Hose Couplings.

A. Purpose - for convenience in handling and replacement, fire hose is usually cut into length of 50 feet. These must be "coupled" together to produce a continuous hose line.

B. Coupling materials - brass and aluminum alloy are materials generally used.

C. Types of couplings.

1. Three-piece coupling.

2. Five-piece coupling.

3. Suction hose coupling.

4. Booster hose coupling.

5. Coupling without expander ring (barway coupling).

D. Rules for the care of couplings.

1. Avoid dropping or dragging disconnected couplings.

2. Do not permit vehicles to run over fire hose.

3. Examine couplings when hose is washed and dried.

4. Clean threads of tar, dirt, gravel, and oil.

5. Inspect gaskets and replace if cracked or creased.

6. Inspect swivel for free movement.

VI. Fire Hose Nozzles.

NOTE: Instructor should explain characteristics of each nozzle.

A. Purpose - to give the fire stream shape and added velocity.

B. Types of nozzles.

1. Adjustable pattern fog stream nozzles.

2. Fixed pattern fog stream nozzles.

3. Master fog stream nozzle tips.

4. Master solid stream nozzles.

5. Handline solid stream nozzles.

6. High pressure fog stream nozzles.

7. Special purpose nozzles.

VII. Fire Hose Adapters.

A. Definition - any appliance in the hose line through which water passes.

B. Types of adapters.

NOTE: These are designed to make use of fire hose more efficient. Instructor should discuss each.

1. Wye connections - for dividing lines into two or more.

2. Siamese connections - for turning two or more lines into one.

3. Water thief.

4. Double male adapter.

5. Double female adapter.

6. Reducers.

VIII. Fire Hose Tools and Accessories.

A. The hose roller.

B. The hose jacket.

C. The hose clamp.

D. Hose spanners and hydrant wrenches.

E. The fire hose control.

F. Fire hose bridges.

G. Chafing blocks.

H. Rope, strap, and chain hose tools.

IX. Fire Hose Rolls and Connections.

A. Procedure for making the donut roll (one man).

1. Lay hose flat in straight line.
2. Start roll off center five or six feet closer to the male end.
3. Near the completion of the roll, the male coupling will be enclosed within the roll as the hose is rolled over it.

B. Procedure for making the donut roll (two men).

1. Lay hose flat in straight line.
2. Fold male coupling over the hose to a point five or six feet from the female coupling.
3. One man starts roll from folded end and second man removes slack, keeping hose straight.

C. Procedure for making the twin donut roll.

1. Lay male and female ends together and parallel to each other. This position forms a loop at the opposite end.
2. Fold the loop end back on the two lines and start the roll. Both lines are rolled simultaneously, forming a twin roll with a decreased diameter.

D. Procedure for making and carrying the self-locking one and one-half inch roll.

1. Place the female and male couplings together, straight and without twist.
2. At the bend, move one side of the hose over to the opposite side to make a loop without twist.
3. Face coupling ends, bring back side of loop forward toward couplings and place on top of where hose crosses. This action forms a loop at each side without twist.
4. Start rolling toward the coupling ends and form two rolls side by side.
5. When rolls are completed, adjust loops, one short and one long. Place long loop through short loop just behind couplings and tighten. Long loop forms a shoulder sling.
6. Place one arm through shoulder sling and adjust on shoulder for carrying.

E. Making hose coupling connections.

1. One-man method.
   a. Hose across upper leg.
   b. One foot on hose behind coupling, with or without hose folded back.
   c. One foot on hose behind coupling.
2. Two-man method.
   a. Two men, holding opposite couplings, stand facing each other.
   b. Man with male coupling holds hose and coupling tightly against upper thigh.
   c. Man with female coupling brings couplings together, aligns, and makes connection.

F. Methods for breaking tight coupling connections.

1. With spanner wrench.

2. One man with foot on hose behind coupling.

3. One man using knee press.

4. Two men, facing each other, using hands.

G. Attaching nozzle to hose.

1. One-man method.

a. Hose across upper leg.

b. One foot on hose behind coupling with hose folded back.

c. One foot on hose behind coupling.

2. Two-man method - follow instructions for making hose coupling connections with two men.

H. Fire hydrant connections.

1. Construction of fire hydrants.

a. Riser with proper connections for fire hose.

b. Control valves.

c. Drainage system.

2. Operation of fire hydrants.

a. To get the best flow, hydrant should be opened completely.

b. Number of turns necessary to open hydrants may vary with the make. (Usually takes 15 or 20 turns to open completely.)

3. Catching a hydrant.

a. A one-man job referring to hydrant connection activity. Hydrant catcher must have cooperation of driver of apparatus, however.

b. Procedure.

(1) Hydrant-catcher gets everything in readiness while enroute to fire.

(2) Driver pulls apparatus close to curb and comes to a complete stop. Hydrant-catcher steps to ground as he removes a supply of hose to the ground. He holds a hose and wrench in the hand that is farthest from the hydrant.

(3) Hydrant-catcher approaches hydrant with hose and wrench in same position. Since the end of the hose is carried by the hand farthest from the hydrant, no hose is in front of the legs during the approach.

(4) Snubbing hose around hydrant - hose is looped completely around hydrant and foot is placed just below coupling.

(5) Remove hydrant cap.

(6) Place wrench on operating nut.

(7) Connect hose.

(8) Turn on hydrant (slowly).

4. Making intake pump connections.

a. Soft suction hookups.

b. Hard suction hookups.

5. The four-way hydrant and pump connection.

X. Fire Hose Carries and Drags.

A. Carrying the nozzle end.

1. On back.

2. Across chest.

B. Procedure for the shoulder fold carry.

1. Take the folds directly from the accordion load for a reverse lay or pick up folds from ground from a forward lay when the accordion load has been removed from the apparatus in flakes.

2. Place folds on shoulder.

3. Nozzle goes to the front of body and on bottom of folds.

4. Hose feeds off from top as man advances.

5. Additional men may carry extra hose slack in like manner.

C. The shoulder loop carry (single action).

D. The shoulder loop drag.

E. The street drag.

XI. Hose Layouts, Loading, and Advancing Fire Hose.

A. Procedure for the forward lay - from hydrant to fire procedure for using two and one-half inch hose.

1. Apparatus stops at hydrant.

2. One man attaches hose to hydrant.

3. Driver proceeds to fire.

4. Fireman pulls off needed hose, attaches proper nozzle and proceeds to fire.

B. Procedure for using one and one-half inch pre-connected hose line with the forward lay.

1. After apparatus reaches fire, fireman pulls off one and one-half inch pre-connected lines and advances to fire.

2. Driver may charge one and one-half inch hose lines using water from booster tank.

3. Driver connects two and one-half inch feeder line from hydrant into pump suction and makes necessary changeover from booster tank supply to hydrant feeder line.

   CAUTION: Hydrant flow through hose line will depend on size of main, existing pressure, length of line, etc.

C. Procedure for the reverse lay - from fire to hydrant procedure for using two and one-half inch hose.

   1. Apparatus stops at fire.
   2. Fireman pulls off necessary hose and nozzle.
   3. Driver lays hose to hydrant.
   4. Driver connects pump to hydrant, hose to pump, and obtains proper fire stream pressure.

D. Procedure for using one and one-half inch pre-connected hose lines with reverse lay.

   1. Apparatus stops at fire.
   2. Fireman pulls off one and one-half inch hose, 2½" x 1½" x 1½" wye and proper nozzles.
   3. Fireman pulls off ample two and one-half inch hose for slack.
   4. Driver lays hose to hydrant.
   5. Driver connects pump to hydrant, hose to pump, and obtains proper fire stream pressure.

E. Fire hose compartments.

   1. Hose capacity.
      a. Two and one-half inch size.
      b. One and one-half inch size.
   2. Construction.

F. Methods for loading fire hose.

1. Loading of hose apparatus is a very vital operation that must be done correctly so that at time of an emergency, hose operations can be carried out efficiently.

2. Basic rules to be observed.

   a. Keep flat sides of hose aligned.

   b. Couplings should be hand-tight.

   c. Keep inside bends of hose folded smoothly in hose compartments.

3. Most commonly used fire hose loads.

   a. The horseshoe load.

      (1) Basic rules for loading.

         (a) Load may be started anywhere around inside walls of hose bed.

         (b) Start with male coupling for forward lay.

         (c) Start with female coupling for reverse lay.

         (d) Minimum of three men should be used.

      (2) Loading procedures.

         (a) Step one.

            i. When hose is started in a front corner, lay hose to rear of hose bed.

            ii. Fold and return to front of bed.

            iii. Bring hose across the front of bed.

            iv. Lay hose along opposite side of bed.

            v. Fold hose around in horseshoe fashion.

            vi. "Dutchman" (extra fold) may be needed.

            vii. Folded ends at the rear may be kept even or staggered.

(b) Step two.

i. To make the crossover to the second tier at the front of the hose bed, place the last fold from the center flat and load toward a front corner.

ii. Loading is resumed as before.

(c) Alternate method.

i. Make crossover in rear of bed.

ii. Bring the last fold in center around the ends of one-half of the tier.

iii. Place between hose tier and side of bed.

iv. Place a short fold in the hose at this point.

v. The crossover should be on alternate sides.

b. The accordion load.

(1) Basic rules for loading.

(a) Start in any corner of hose bed.

(b) Start with male coupling for forward lay.

(c) Start with female coupling for reverse lay.

(d) Minimum of three men should be used.

(2) Loading procedures.

(a) Step one.

i. When hose is started in a front corner, lay hose to rear of hose bed where it is folded toward the front.

ii. Same procedure is continued as hose is folded back and forth in bed.

iii. Folded ends may be kept even or staggered.

iv. "Dutchman" may be needed.

(b) Step two.

i. The second tier may be started by gradually raising the last fold from front to rear along side of bed.

ii. After hose is raised, start a new tier.

iii. Hose is folded in same manner as first tier of hose.

(3) Alternate method.

(a) Some departments choose to start second tier by crossing over so hose will always play out from the same side of the hose bed.

(b) This is done by bringing the start of second tier across front of hose bed to corner where original start was made.

(c) Hose is placed down original side and loading is resumed.

c. The flat load.

(1) Rules for loading.

(a) Start in any corner of hose bed.

(b) Start with male coupling for forward lay.

(c) Start with female coupling for reverse lay.

(d) Minimum of three men should be used.

(2) Loading procedures.

(a) Step one.

i. When hose is started in a front corner, lay hose along one side to the rear of hose bed.

ii. Fold hose back toward the front and lay it at a slight diagonal in order to start second flake alongside the first.

(b) Step two.

i. Make each succeeding flake in same manner until tier is full.

ii. Start second tier by folding the first flake on top of the completed tier and fold back to beginning side.

(c) Step three - fold ends of the flakes so that they are staggered to permit the center of hose bed to fill evenly.

G. Special hose loads.

NOTE: Instructor should identify each.

1. The reverse horseshoe load.
2. The pre-connected flat load.
3. The self-locking one and one-half inch roll assembly load.
4. The skid load.
5. The cisco load finish.
6. The "figure 8 coil" load.
7. The "cable coil" load.

H. Methods for unloading and advancing fire hose.

1. Unloading and moving hose to an advantageous fire fighting position requires teamwork and harmony.

a. An inadequate supply may cause serious delay in reaching fire.

b. Excess of hose may tie up hose needed elsewhere.

2. Most commonly used unloading and advancing procedures.

a. Unloading and advancing two and one-half inch hose.

(1) Basic rules.

(a) Unload hose in flakes from hose bed so that it can be dragged or carried from point of pull-off to point of operation.

(b) The nozzle end of the hose should always be toward the fire when unloading is completed.

(c) The hose may be unloaded in flakes from the horseshoe load, the accordion load, or the flat load.

(d) Length of flakes depends upon the length of the bed and the load used.

(2) Procedure.

(a) Fire fighter steps on tailboard and grasps two loops, one in each hand, ready for the pull-off.

(b) Loops are pulled off and carried back from the tailboard in a straight line.

(c) Additional flakes of hose are pulled off in the same manner.

(d) It is very important that the fire fighter unload a sufficient amount of hose in the pull-off to allow advancement of the nozzle into a working position.

(e) Advancing of hose may be done by means of the shoulder fold carry.

b. Procedures for unloading and advancing the pre-connected one and one-half inch reverse horseshoe load (two-man operation).

(1) First man pulls large loops of the top tier a short distance out of the hose bed.

(2) He then places nozzle over his left shoulder, inserts his right hand and arm up through loops and places hose over right shoulder.

(3) The nozzle and loops are held secure and first man advances from apparatus about 20 feet where he pauses for second man to load.

(4) Second man loads himself in same manner, then both men advance toward fire.

(5) As the line is advanced and becomes tight behind second man, hose is fed from the loops on the shoulder.

c. Unloading and advancing one and one-half inch hose wyed from two and one-half inch hose.

d. Unloading and advancing the skid load finish.

e. Unloading and advancing the pre-connected one and one-half inch self-locking hose load.

f. Unloading and advancing the cisco load finish.

g. Advancing two and one-half inch or one and one-half inch hose up a stairway.

(1) Advance hose dry.

(2) Advance hose by carrying. Do not drag.

(a) Shoulder fold carry.

(b) Shoulder loop carry.

(c) Underarm carry.

h. Advancing hose up a ladder.

(1) For safety, speed, and ease, two and one-half inch hose should be advanced dry.

(2) Nozzle man carries hose on shoulder while other men carry hose by using rope hose tools.

(3) Men should climb 10 feet apart and there should be 20 to 25 feet of hose between them.

i. Procedures for passing hose up a fire escape or a ladder by means of pike pole.

(1) Use rope hose tools, hose strap, or hose chain to fasten pike pole to nozzle.

(2) Good practice for raising and lowering a dry line.

(3) Up a ladder.

(a) Men spaced 10 to 12 feet apart on ladder.

(b) Pike pole is passed from one man up to another.

(c) Man on ground feeds slack to men on ladder.

(4) Up a fire escape.

(a) Men spaced on each landing of fire escape.

(b) Pike pole is passed from one man to another.

(c) Man on ground feeds slack to men on fire escape.

j. Hoisting hose with rope and hose roller.

(1) Hoisting.

(a) Hoist dry line.

(b) Fold end back so end points opposite direction of travel.

(c) Tie using clove hitch at end and half hitch at fold.

(d) Hose roller is placed in window or on ledge and tied.

(2) Lowering.

(a) End of hose points in opposite direction of travel.

(b) Clove hitch and half hitches are placed without nozzle end folded back.

k. Methods for replacing a section of hose.

(1) Apply hose clamp or kink hose.

(2) Replace section.

(3) If burst section is on ladder or other vertical position, lower hose line to ground and replace.

(4) Mark burst section for repair or discard.

XII. Feeding Private Protection Devices and Special Appliances.

A. Standpipe systems.

1. Purpose - for private protection and fire department use.

2. Water supply for standpipe systems.

a. City mains.

b. Overhead tanks.

c. Other sources.

3. Parts of the standpipe system.

a. Street connections.

b. Risers.

c. Connecting pipes.

d. Gate valves.

e. Check valves.

4. Procedure for feeding standpipe systems.

a. Remove protector plate.

b. Check gasket.

c. Check for foreign materials in siamese connection.

d. Connect hose to siamese.

B. Master stream appliances.

1. Purpose - for fires that have attained considerable headway and require large volumes of water to be delivered a considerable distance.

2. Kinds of master stream appliances.

a. Deluge set.

b. Monitor.

c. Deck pipe.

d. Ladder pipe.

3. Feeding procedures.

a. Check gaskets.

b. Connect hose lines to intakes.

C. Foam generators.

1. Principles of foam generation (chemical).

2. Generator design.

NOTE: Names of generator types refer to method by which powder is fed into generators.

a. One-powder type.

b. Two-powder type.

3. Operating procedure.

a. Location of generator (approximately 100 feet from fire).

b. Intake pressure (75-100 p.s.i.).

c. Length of discharge line (100-150 feet).

d. Size of nozzle (one and three-fourths inches).

e. Shut off valve on intake side.

f. Keep powder dry.

D. Foam and wet-water proportioners.

1. Generation of mechanical foam.

a. Proportioner.

b. Playpipe.

2. Operating principle.

a. Proportioner.

b. Playpipe.

3. Operating pressures.

a. Proportioner.

b. Playpipe.

4. Operating precautions for proportioner and playpipe.

a. Observe manufacturers' recommendations for each.

b. Keep kinks out of line.

XIII. Testing Fire Hose.

A. Frequency of test.

1. New hose.

2. Used hose.

B. Methods of testing.

1. Fire department pumper.

2. Small pump.

C. Testing procedure.

1. Remove air.

2. Raise pressure slowly to required test pressure.

3. Observe hose for defects.

4. Hold pressure for five minutes.

5. Lower pressure slowly.

6. Inspect hose.

XIV. Hose Inspection Records.

A. Purpose - to have a case history of a section of hose from time of purchase until it is taken out of service.

B. Each section should be numbered and a card record or book kept with the following information:

1. Hose number.

2. Size hose.

3. Kind.

4. Date of purchase.

5. Manufacturer.

6. Brand.

7. Cost.

8. Purchased from.

9. Guarantee.

10. Guarantee expires.

11. Date of test.

12. Pounds tested to.

13. Time tested.

14. Remarks.

References:

International Fire Service Training Association Manual.

Hose Practices

Fire Service Practices for Volunteer Fire Departments. The Department of Fire Protection Technology, Oklahoma State University, Stillwater, Oklahoma.

PART VIII: FORCIBLE ENTRY

I. Terms Used in the Building Trade.

A. Sill.

B. Joist.

C. Rough or sub-floor.

D. Finish floor.

E. Stud.

F. Sheathing.

G. Wood siding.

H. Rafters.

I. Roof decking.

J. Ridge board.

K. Fire stops.

II. Conditions Requiring Forcible Entry.

A. Areas where normal openings are locked.

B. Areas where normal openings are blocked.

C. Areas where openings are not provided.

III. Forcible Entry Tools.

A. A variety of tools have been devised to make forcible entry possible. Many of the fireman's best tools are homemade and have come from experimenting on ideas that grew out of emergency situations.

B. More commonly used forcible entry tools.

1. Kelly tool.

2. Claw tool.

3. Halligan tool.

4. Battering ram.

5. Pick head axe.

6. Flat head axe.

7. Pompier hatchet.

8. Crowbar.

9. Spanner wrench.

10. Wire cutters.

11. Wrecking bar.

12. Pike pole.

13. Electric saw.

14. Oxyacetylene cutting unit.

15. Detroit door opener.

IV. Doors.

A. Types of doors.

1. Swinging.

2. Revolving.

3. Overhead.

4. Fire.

B. Construction of swinging doors.

1. Metal swinging doors and jambs.

a. Structural design.

(1) Hollow metal.

(2) Metal covered.

(3) Tubular metal.

b. Door jambs.

(1) Rabbeted.

(2) Stopped.

2. Wood swinging doors and door jambs.

a. Structural design.

(1) Panel.

(2) Slab.

(a) Hollow core.

(b) Solid core.

(3) Ledge (batten).

b. Door jambs.

(1) Rabbeted.

(2) Stopped.

c. Swinging door locks and fasteners.

(1) Bolt.

(2) Bar.

3. Opening metal and wood swinging doors - (check to see how door is hung and how it swings).

a. Doors that open toward operator.

b. Doors that open away from operator.

(1) Stopped jamb.

(2) Rabbeted jamb.

c. Double swinging doors.

NOTE: Locks for swinging doors generally consist of a bolt or bar that protrudes from door stile. The jamb must be sprung enough to permit the bolt to pass the keeper during forcible entry.

4. Tempered plate glass swinging doors.

a. Tempered glass doors are constructed for strength and flexibility.

b. To break or gain entrance through tempered glass doors.

(1) Shield operator with face shield or place old salvage cover over door and strike blow through cover.

(2) Use pick point of a standard fire axe, not the flat side.

(3) Cut the lock bar.

(4) Drive cylinder lock out of the door.

C. Revolving doors.

1. Construction of revolving doors.

a. Metal-clad quadrants.

b. Mechanism is usually collapsible and panic-proof.

c. Locks - each wing is held by hangers at top and bottom.

2. Forcing revolving doors.

a. Collapse hangers and fold door.

b. If door is locked, spring lock or break glass sections.

D. Overhead doors.

1. Overhead folding doors.

a. Construction.

(1) Wood framework with plywood or glass panels.

(2) Some are made of aluminum.

b. Forcing overhead folding doors.

(1) Knock out panel.

(2) Turn latch from inside.

2. Overhead slab doors.

a. Construction.

(1) Aluminum.

(2) Wood.

b. Forcing overhead slab doors.

(1) If glass windows are provided, break glass and operate from inside.

(2) If windows are not provided, apply a bar at each side of the door near the bottom and pry outward.

3. Overhead rolling doors.

a. Construction.

(1) Usually made from fabricated steel or aluminum.

(2) Door is wound on a barrel and turned by a set of gears.

b. Forcing overhead rolling doors.

(1) Using portable oxyacetylene cutting torch, cut a hole large enough for a man to enter and operate the door from inside, or

(2) Using heavy bar, pry door up at bottom a short distance to permit insertion of step jack. Leverage of the step jack will raise the door high enough for entrance.

(3) If heat damages retracting springs causing door to appear locked, prop door open after raising it.

E. Fire doors.

1. Types of fire doors.

a. Swinging.

b. Sliding.

c. Rolling.

d. Counterbalanced.

2. Forcing fire doors.

a. Fire doors, because of their protective qualities, generally are not considered as doors that need to be forced.

b. Fire doors that close automatically need only to be pried open with suitable forcible entry tools.

c. Fire doors on exterior openings may be locked and the lock must be forced.

NOTE: As a precautionary measure, firemen should block a fire door open as they pass through it to insure that the door will not close and trap them on the opposite side. The water supply in a hose line could also be cut off by a closing fire door.

V. Windows.

A. Types of windows.

1. Double hung or check rail - made of wood or metal.

2. Hinged or casement - wood or metal with one or two sashes.

3. Factory or projected - usually metal, may project in or out.

4. Awning or jalousie - wood, metal, without frame or jalousie.

B. Forcible entry through windows.

1. Forcing double hung or check rail windows.

a. Almost any prying tool may be used.

b. Insert tool in center of bottom sash and pry up.

c. Break glass and unlock.

2. Forcing hinged or casement windows.

   a. Break pane of glass nearest latch. (Clean out sharp edges.)

   b. Force or cut screen.

   c. Reach in, unlock latch and then operate cranks and levers.

   d. Remove screen completely and enter.

3. Forcing factory or projected windows (see techniques for forcing casement windows).

4. Forcing awning or jalousie windows.

   a. To remove a section of the awning window, cut the pins that hinge the sections to the metal frame.

   b. To remove several sections of the jalousie window to permit entrance, use a forcible entry tool.

      NOTE: Because of the cost of jalousie windows, this practice is not recommended unless absolutely necessary.

VI. Roofs.

A. Types of roofs.

1. Flat.

2. Pitched.

3. Arched.

B. Flat roofs.

1. Construction materials for flat roofs.

   a. Concrete.

   b. Gypsum.

   c. Wood.

   d. Layer construction.

2. Opening techniques for flat roofs.

a. Select location for opening.

b. Make opening square or rectangular (to facilitate easy repair).

c. Locate joists by bouncing axe on roof, sounding for solid support.

d. Remove roofing material.

e. Methods for cutting wooden decking.

(1) Cut diagonally along side of joist.

(2) Avoid cutting joists.

(3) Make one large hole rather than several small holes.

(4) Use pike pole or other suitable tools to push through ceiling below.

C. Pitched roofs.

1. Construction of pitched roofs.

a. Rafters (wood or metal).

b. Decking.

(1) Wood sheathing.

(2) Gypsum slabs.

c. Roofing materials.

(1) Shingles - wood, metal, composition, asbestos, cement, slate, tile.

(2) Roofing paper - mopped with asphalt roofing tar.

2. Opening techniques for pitched roofs.

a. Place roof ladder on either side of selected location (usually at highest point).

b. Locate rafters by bouncing axe on roof, sounding for solid supports.

c. Rip off shingles and roofing felt.

d. Cut sheathing along side of rafter the distance required for the opening. The opposite side of the opening may be cut in like manner.

e. Remove sheathing boards.

D. Arched roofs.

1. Construction of arched roofs.

a. Bow string.

b. Trussless.

2. Opening techniques for arched roofs.

a. Opening techniques - same as for flat or pitched roofs except for use of a roof ladder.

b. Long straight ladders, extension ladders and/or aerial ladders - used due to the roof curvature.

NOTE: Proper safety precautions should be observed - ropes, rubber soles, boots, etc.

E. Roof covers and opening techniques.

1. Roof hatches.

a. Metal - generally locked from below.

b. Wood - generally locked from below.

2. Skylights.

3. Shaft openings.

4. Opening techniques.

a. Force locks or locking devices.

b. Pry open with forcible entry tool.

VII. Using and Caring for a Fireman's Axe.

NOTE: Instructor should explain fully the following terms and methods.

A. Proper way to carry the axe.

1. In a belt.

2. In the hand.

B. Construction of the axe.

1. Axe head.

a. Body blade.

b. Pick.

c. Weight.

2. Handle.

a. Material.

b. Shape.

c. Thickness of shoulders.

d. Thin grip.

e. Finish.

C. Care of axe.

1. Prevent heating.

2. Keep wedge tight.

3. Protect finish of handle.

4. Keep point and blade sharp. (After blade is sharpened, fireman should rub lightly over the stone to take off keen edge.)

D. Using the axe.

1. Cutting with axe - position of hands, stroke, relation to surface, relation to joists or rafters.

2. Prying.

3. Breaking glass.

VIII. Floors.

A. Types of floors and coverings.

1. Wood floors.

2. Concrete floors.

3. Floor coverings (special kinds).

B. Wood floors.

1. Construction of wood floors.

a. Wood joist - (fire cut explanation).

b. Sub-flooring.

c. Top or finish flooring.

2. Procedures for opening wood floors.

a. Locate joist by bouncing axe on floor, sounding for solid supports.

b. Cut top-flooring.

c. Cut sub-flooring.

d. Open with electric saw, chain saw, or axe.

C. Concrete floors.

1. Construction features to consider.

a. Reinforcing metal rods or wire.

b. Thickness.

2. Tools for opening concrete floors.

NOTE: It is best to find another means of entrance if possible.

a. Jack hammer.

b. Special heavy duty tools.

IX. Exterior Walls, Partitions, and Ceilings.

A. Masonry wall.

1. Construction materials.

a. Brick.

b. Stone.

c. Concrete block.

d. Brick veneer.

e. Glass block.

2. Opening, breaching, or breaking masonry walls.

a. Battering ram.

b. Hammerhead pick.

B. Wood frame walls.

1. Construction of wood frame walls.

a. Studs.

b. Interior sheathing.

c. Exterior siding.

2. Opening wood frame walls - (see techniques for opening roofs and floors).

C. Metal walls.

1. Construction materials.

a. Aluminum.

b. Iron.

2. Opening metal walls - tools used.

a. Metal cutting bars.

b. Oxyacetylene cutting torch.

NOTE: Caution students to watch for water pipes and electric wires when opening walls.

D. Partitions.

1. Construction of partitions.

a. Hollow clay tile.

b. Covered wood or metal studding.

c. Gypsum blocks.

2. Procedure for opening partitions.

a. Select location for opening with care to avoid electric wall plugs and switches.

b. Have sufficient tools - picks, axes, sledges, and pry bars, etc.

c. If studding is wood or metal, locate studs and cut along side with fire axe.

d. If partition is hollow clay tile or gypsum blocks, crush one or two blocks and the others will remove more easily.

E. Ceilings.

1. Construction of ceilings.

a. Regular ceilings.

(1) Lath and plaster.

(2) Ceiling tile.

(3) Sheet metal.

(4) Gypsum wall board.

b. Drop ceilings (false ceilings).

2. Procedures for opening ceilings.

a. Using pike pole or plaster hook, break plaster or penetrate ceiling material.

b. Pull off lath or ceiling materials.

3. Safety precautions for opening ceilings.

a. Do not stand under opening.

b. Pull down and away from operator.

c. Wear helmet.

d. Stand between work and opening by which retreat could be made.

F. Forcing miscellaneous openings.

1. Construction obstacles.

a. Freeing bars in masonry.

b. Removing sidewalk gratings.

c. Removing wire mesh from windows and doors.

2. Tools for miscellaneous openings.

a. Sledge hammer.

b. Chisel.

c. Hammerheaded pick.

d. Pry bar.

e. Oxyacetylene torch where other means fail.

G. Procedures for breaking glass.

1. Operator should stand at safe distance.

2. Strike lowest point of window.

3. Use flat side of forcible entry tool.

4. Clear broken fragments from sash.

References:

International Fire Service Training Association Manuals:

Forcible Entry, Rope and Portable Extinguisher Practices

Fire Service Practices for Volunteer Fire Departments

Published by: The Department of Fire Protection Technology
Oklahoma State University
Stillwater, Oklahoma

PART IX: RESCUE AND FIRST AID

I. Primary Functions.

A. Recovering victims of hazardous incidents.

B. Conveying victims to a safe place.

C. Rendering essential first aid to victims.

NOTE: A first aid course is not included in this text. It is desirable that in an "Industrial Fire Brigade":

1. Each member complete an American Red Cross standard first aid course.

2. Members have advanced first aid training whenever possible.

3. A number of the members should qualify as instructors in first aid. The necessary classes can be arranged with the local American Red Cross chapter.

II. Secondary Functions.

A. Recovering and removing human bodies.

B. Making the area safe for rescue workers.

1. Shore structures to prevent further sinking, sagging or falling.

2. Demolish dangerous structures.

3. Correct other hazardous conditions for plant safety.

C. Assisting public utility personnel.

1. Roping of area.

2. Providing lights.

D. Enlistment of special equipment to remove hazardous debris.

1. Cranes.

2. Bulldozers.

3. Trucks.

III. Incidents and Situations Involving Rescue Work.

A. Types of buildings.

1. Burning buildings.

2. Demolished buildings.

a. Due to explosion.

b. Collapse due to structural failure.

B. Gaseous areas.

NOTE: Instructor should give description of rescue situations created by each gas type.

1. Industrial gases.

a. Fuel gases.

(1) Natural.

(2) Liquified petroleum.

(3) Artificial.

b. Refrigerants.

c. Fumigants.

d. Anesthetics.

e. Processing gases.

2. Fire gases - hazardous gases are likely to be created by fire and must be dealt with by using common sense and good judgment.

a. Smoke.

b. Carbon dioxide.

c. Carbon monoxide.

d. Nitrogen oxide from burning materials.

3. Gases from decomposition.

a. Decomposition of organic material.

(1) Plant matter.

(2) Animal matter.

b. Sewer gas.

C. Electrical contact.

1. Coming in contact with electricity either by direct or indirect means.

2. Use caution in rescue of victims in contact with electricity.

D. Earth cave-ins.

1. Ditching.

2. Excavating.

3. Tunneling.

E. Water accidents.

F. Storms and floods.

G. Transportation accidents.

H. Panics.

I. Other accidental occurrences.

1. Open sewer manholes.

2. Slippery streets.

3. Scaffolding accidents and other falls.

IV. Personal Protection Requirements.

A. Fire fighters must protect themselves against.

1. Weather.

2. Extinguishing agents.

3. Heat.

4. Accident causes.

B. Hazards to rescue workers.

1. Irritant gases.

    a. Ammonia.

    b. Hydrogen chloride.

    c. Sulfur dioxide.

    d. Chlorine.

    e. Nitrous fumes.

    f. Phosgene.

2. Asphyxiant gases.

    a. Carbon dioxide.

    b. Hydrogen.

    c. Methane.

    d. Ethane.

    e. Carbon monoxide.

    f. Hydrogen cyanide.

3. Anesthetic gases and vapors.

    a. Propane.

    b. Butane.

    c. Gasoline.

    d. Kerosene.

    e. Naphtha.

    f. Acetylene.

    g. Acetone.

    h. Methyl ethyl ketone.

    i. Methyl chloride.

    j. Carbon tetrachloride.

    k. Trichlor ethylene.

l. Toluene.

m. Methyl alcohol.

n. Carbon disulfide.

C. Interstate Commerce Commission labels for packages containing dangerous materials.

1. Red label with black printing (size 4" x 4").

a. Flammable liquids (diamond shape).

b. Flammable gases (diamond shape).

c. Special fireworks (square).

d. Explosives (square).

e. Samples of explosives (square).

f. Propellant explosives (square).

2. White label with black printing (size 4" x 4").

a. Acids (diamond shape).

b. Corrosive liquids (diamond shape).

c. Alkaline caustic liquids (diamond shape).

3. White label with red printing (size 4" x 4").

a. Poison gas (diamond shape).

b. Poison (diamond shape).

c. Tear gas (diamond shape).

d. Radioactive materials Group I or II (diamond shape).

4. White label with blue printing (size 4" x 4") - radioactive materials Group III emitting corpuscular rays only (diamond shape).

5. Yellow label with black printing (size 4" x 4") - flammable solids and oxidizing materials (diamond shape).

6. Green label with black printing (size 4" x 4" - nonflammable compressed gas (diamond shape).

V. Rescue Procedure.

A. Sizing up the situation.

1. Reviewing the facts.

a. Time of the emergency.

(1) Hour.

(2) Day.

(3) Month.

b. Situations and type of rescue needed.

(1) Burning building.

(2) Demolished building.

(3) Gaseous area.

(4) Electrical contact.

(5) Earth cave-ins.

(6) Water accident.

(7) Storms and floods.

(8) Transportation accidents.

(9) Panics.

(10) Accidental occurrences.

c. Prevailing weather conditions.

(1) Windstorm.

(2) Wind - direction and velocity.

(3) Rain-snow-ice.

(4) Relative humidity.

(5) Temperature.

2. Anticipating conditions.

a. Probable life hazards.

(1) Occupants.

(2) Spectators.

(3) Personnel.

b. Development of fire.

(1) Extent.

(2) Spread.

(3) Explosions.

(4) Building collapse.

(5) Probabilities.

3. Available aid.

a. Personnel and equipment.

(1) Fire apparatus.

(2) Rescue equipment.

(3) Regular personnel.

(4) Call men.

(5) Volunteer workers.

b. Additional assistance available.

(1) Organized disaster plan.

(2) Civil defense rescue teams.

(3) Trained first aid workers.

(4) American Red Cross.

(5) Salvation Army.

B. Determining rescue procedures.

C. Guides for locating victims.

1. Rescue victims who can be seen and heard.
2. Locate victims in an orderly manner.
3. Use caution while moving around to avoid further building collapse.
4. Trapped victims may be located by calling or tapping on pipes or other objects.
5. Rescuers avoid unnecessary talking and yelling.
6. Listen for moans or muffled sounds.
7. Rescue workers should work in pairs.

D. Reaching trapped victims.

1. In a burning building.

a. Safety precautions.

(1) Wear protective clothing, breathing equipment.

(2) Use rope handlines for signaling.

(a) Two pulls - advance.

(b) Three pulls - retreat, come out at once.

(c) Four pulls - distress, need help.

(3) Work in pairs.

b. Rescue aids.

(1) "Walkie-talkie".

(2) Portable telephones.

(3) Fire fighting equipment.

(a) Hose streams.

(b) Ladders.

2. In a demolished building.

a. Lightly trapped victims (rescue can be accomplished quickly).

b. Heavily trapped victims (rescue is complicated and requires more time).

c. Access is restricted by position of.

(1) Heavy beams.

(2) Collapsed walls.

(3) Collapsed floor or roof sections.

(4) Piles of debris.

d. Types of collapse and formation of void.

(1) Lean-to-floor collapse.

(2) Pancake floor collapse.

(3) V-shape floor collapse.

e. Tunneling (horizontal, vertical, or diagonal).

(1) Slow dangerous work.

(2) Use as last resort.

(3) Carried out from lowest possible level.

f. Shoring - only temporary shoring should be done by rescue squads.

3. In a gaseous area.

4. In contact with electrical energy.

5. In earth openings.

6. Underwater.

E. Conditions in which victims may be expected.

1. Trapped in a void.

2. Pinned beneath obstructions.

3. Injured.

4. Burned.

5. Unconscious.

6. In shock (traumatic).

7. Intoxicated.

8. Panicky.

F. Procedure for releasing and caring for victims.

1. Emergency first aid.

2. Removal of victim to a safe place.

3. Recognize clearance requirements and exercise caution before rescue work is carried out.

VI. Rescue Practices and Techniques.

NOTE: Rescue practices and techniques consist of jobs and operations necessary to carry out a rescue.

A. Assisting victim to walk.

1. One-man method.

a. Place victim's uninjured arm over rescuer's shoulder and behind his neck.

b. Rescuer grasps victim's hand and passes his other arm around his waist.

c. Assist slightly injured victim to walk.

2. Two-man method.

a. Victim puts an arm over the shoulder and behind the neck of either rescuer.

b. Each rescuer grasps victim's hand and passes his other arm around his waist.

c. Assist victim to walk, or practically all weight of victim can be borne by rescuers.

B. Carrying a victim.

1. Astride the back (one-man).
   a. Assist victim to standing position.
   b. Turn back to victim.
   c. Take victim's arms over shoulders and cross them.
   d. Bend forward and raise victim well upon back.
   e. Pass forearms under victim's legs and take a wrist in either hand.
2. Pack strap method (one-man carry for unconscious victim).
   a. Rescuer makes loop of any convenient material.
   b. Turn victim on his stomach and pass loop around his chest at the armpits.
   c. Rescuer places himself on his back flat on the victim and slips each arm through loop ends.
   d. Rescuer rolls himself and victim over onto his hands and knees, then gets to his feet with victim secured to his back.
3. Seat carry (two-man).
   a. Rescuers kneel, one on either side of victim, near victim's hips and raise him to a sitting position.
   b. Rescuers steady victim and place arms nearest his head around his back, clasping the shoulder of the other.
   c. Rescuers slip the other arm under victim's thighs, clasping the wrist of the other.
   d. Rescuers arise slowly together, lift the victim from the ground.
4. Extremities carry (two-man).

5. Chair carry (two-man).

6. Three-man carry.

a. Three men line up on one side of victim.

b. At command "prepare to lift", each man kneels on knee nearest victim's feet.

c. Without further orders, rescuers pass hands and forearms under victim.

(1) Head man - under neck and back.

(2) Middle man - under pelvis and knees.

(3) Foot man - under knees and ankles.

d. At command "lift", they raise victim and place him on their knees.

e. At command "prepare to raise", they slowly turn victim on his side toward them until he rests in the bend of the elbows.

f. At command "rise", all rise to a standing position holding victim against their chests.

C. Dragging a victim (one-man).

1. Incline drag.

a. Place victim on back, head downward.

b. Crouch at victim's head and grasp him under armpits.

c. Victim's head is supported in the crook of rescuer's arms.

2. Mattress splint technique (two-man).

a. Rescuers fold the sides of a mattress along each side of patient.

b. Sides of mattress are secured in place by two twisted sheets, one tied around mattress at patient's chest, the other at patient's knees.

c. Lift mattress and patient to floor and drag him to safety.

D. Stretcher transportation - for severely injured victims.

1. Types of stretchers used.

a. Army stretcher.

b. Folding stretcher.

c. Stokes Navy stretcher.

d. Improvised stretchers.

(1) Using two poles and two or three jackets.

(2) Using two poles and blanket or salvage cover.

(3) Ladder.

2. Placing victim on a stretcher.

a. Raise victim in same manner as described in three-man carry.

b. Gently lower victim to stretcher by reversing lifting procedure.

E. Lowering and raising a victim (where rescue through natural exits are blocked).

1. Guiding a victim down a ladder.

a. Rescuer proceeds below the victim.

b. Place arms around victim underneath armpits.

c. Keep one knee placed between victim's legs.

d. If victim becomes unconscious, his feet and hands should ride outside beams of ladder.

2. Lowering victim via ladder and lifeline.

a. Raise ladder to a point above window where rescue is to be made.

b. Pass line under bottom rung.

c. Rescuer climbs, feeding line to underside of ladder.

d. When rescuer reaches bottom of window sill, line is threaded back through rungs, up and over three consecutive rungs.

e. Enough line is then fed through the window where the tie is made.

f. Victim is then swung from window and lowered by men on ground.

3. Rescue knots.

NOTE: Refer to ROPE PRACTICES in the Fire Service Training outline for specific instructions.

a. Bowline-on-a-bight.

b. Double bowline.

4. Lashing victims for lowering or raising.

a. Lashing victim on stretcher.

(1) Wrap victim in blankets or salvage cover and place on stretcher.

(2) Using a lashing rope, start with a clove hitch on one of stretcher handles nearest head.

(3) Pass the rope down one side of the stretcher.

(4) Take a complete turn underneath and back over victim's chest, making a half hitch at the side.

(5) Take a complete turn underneath and back over victim's hips, making a half hitch at the side.

(6) Take a complete turn underneath and back over just below victim's knees, making a half hitch at the side.

(7) Pass rope around victim's feet and up opposite side of stretcher, making a half hitch at each turn.

(8) Secure with clove hitch on opposite handle.

b. Lashing victim on improvised stretcher (ladder).

(1) Wrap victim in blankets or salvage cover and place on ladder.

(2) Using a lashing rope, start with clove hitch on beam of ladder one rung above victim's head.

(3) Taking complete turns underneath and back over victim, making half hitches at victim's chest, hips, and below the knees.

(4) Pass rope between victim's feet and make two additional half hitches around ladder.

(5) Secure with clove hitch on rung below victim's feet.

5. Methods of lowering victims on stretchers or improvised stretchers.

NOTE: Instructor should demonstrate techniques and tools used.

a. Horizontal.

(1) One-point suspension method.

(2) Four-point suspension method.

b. Vertical.

F. Other means of escape (descending).

1. Life belt and lifeline.

2. Life net.

G. Raising and lowering devices.

1. The aerial ladder.

2. The jib.

3. The gin pole.

4. A-frame.

5. Tripods.

References:

International Fire Service Training Association Manuals:

Rescue Practices

Fire Service Practices for Volunteer Fire Departments

Published by: The Department of Fire Protection Technology
Oklahoma State University
Stillwater, Oklahoma

PART X: SPRINKLER SYSTEMS

I. Definition.

A sprinkler system, for fire protection purposes, may be defined in principle as a network of specially sized piping which is usually installed throughout a building, generally at the ceiling, and to which heat actuated sprinkler heads are connected and systematically spaced. The system is connected to a suitable water supply through a controlling valve and to a device for sending an alarm when the system is in operation. The system is usually activated by heat from a fire. Subsequently, water is discharged over the fire which could have started at any point covered by the system.

II. General Types of Automatic Sprinklers.

A. Wet pipe system.

B. Dry pipe system.

NOTE: Use overlays of wet pipe and dry pipe systems.

III. Inspections.

A. In general, members of the brigade will not have inspection duties unless they receive special instruction; however, every member should be aware of some of these inspection duties.

B. Control valves.

1. General information.

a. Control valves should be inspected at regular intervals, preferably at least once a week.

b. Control valves should be numbered and each should have a sign indicating the portion of the system that it controls.

c. A valve inspection report blank should be used and it should show that valves are:

(1) Open or closed.

(2) Properly secured or sealed.

(3) In good operational condition, turn easily, and do not leak - (sealed valve should not be turned).

(4) Readily accessible with operational wrenches in place.

2. Post indicator valves (P. I. V.).

a. Should be tried with wrench at each inspection, unless sealed.

b. Should be left about one-quarter turn from the wide open position so that they will not be jammed open.

c. Stems and indicating mechanism should be oiled at least once a year.

d. Wrenches should be fastened to valve or kept nearby.

3. Hub end gate valves (underground).

a. Location should be clearly indicated by a sign.

b. Wrench should be located nearby and properly marked.

4. Outside screw and yoke valves (O. S. and Y. valves).

a. Position of stem indicates whether valve is wide open or not.

b. Valve stems should be kept clean.

5. Valves in pits.

a. Access to pits should be free.

b. The pits should be kept clear of water and silt, and they should be properly protected against freezing.

C. Gauges.

1. At the weekly inspection of control valves, read the gauges showing water and air pressure on the system to make sure that normal pressures are being maintained.
2. System gauges should be checked with a regularly calibrated inspector's gauge once each year.

D. Flow tests.

1. At intervals specified by the plant maintenance department or by the insurance engineers, make a water flow test:
   a. From test pipes at the top of the systems (wet pipe systems only).
   b. From the main drain valves of the systems.
2. Operate test switches on electric alarm devices or operate water motor alarms weekly.
3. Make sure that the small valve or cock controlling the water supply to alarm devices is secured in its normal open position.
4. Where there is central station supervision of alarm valves or waterflow connections to fire department, notify the central station or fire department before operating any valve or otherwise disturbing the sprinkler system.

E. Sprinkler dry pipe valves.

In general, the operation and servicing of these valves are handled only by experienced men assigned to this duty. Some of the more important points to be covered in an inspection follow:

1. Check weekly to see that the air pressure on the system is kept at the required level. (Consult manufacturer's instructions.)

2. See that priming water is maintained at the proper level above the air seat of the dry pipe valve.

3. In cold weather, see that the valve enclosure is properly heated, thermostatically controlled, and that the heating equipment is in order.

4. Before and during freezing weather, see that all low point drains of the dry pipe system are free of water. Also check antifreeze systems or close cold weather valves and open drains in the exposed piping.

5. Once a year, during warm weather, it is desirable to clean thoroughly and reset each dry pipe valve. The authority having jurisdiction should be consulted.

F. Automatic sprinklers.

1. Check sprinkler heads to make sure they are proper type, in proper position and good condition, clean, free from corrosion, not painted or whitewashed, and not bent or damaged.

2. Assure that an <u>adequate</u> supply of extra sprinkler heads are available.

3. Make sure that sprinkler piping is in good condition and has not been mechanically injured. See if any hangers are broken and need replacing.

4. Note if any partitions have been erected which require the extension of sprinkler lines.

5. Note cases where stock is piled so closely under sprinkler heads that the water from the heads cannot readily distribute over the stock piles.

a. The minimum distance below sprinklers is 18 inches with increased clearance up to 36 inches, over large, closely packed piles of combustible cases, bales, cartons, or other closely packed combustible stock. Check applicable regulations for stock piling.

IV. Fighting Fire in a Building Equipped With Sprinklers.

Where a plant is protected by a well-designed and carefully maintained system of automatic sprinklers, the fire brigade's work is simplified in a majority of fires. A mistake that poorly trained brigades sometimes make is to lay hose lines for fire fighting in such a way that hose streams take water which could better be put on the fire through the sprinkler systems.

A. In deciding what to do first at a sprinklered fire, it usually may be assumed that a few heads will open and control the fire. A man should be sent to the control valve to:

1. Determine promptly that the sprinklers are operating.
2. Check the main control valve; it must be completely open.
3. Shut the valve only when ordered to do so by the officer in command of the fire fighting operations.
4. Remain at the valve so that in the event of rekindling or any detected extension of the fire, the valve can be reopened promptly.
5. It is very important for a man to remain at the valve until the protection is restored.

NOTE: The authority having jurisdiction may require that a 2-inch drain test be made before protection is considered restored.

B. The first or second pumper company to arrive should hook up to supply the fire department sprinkler connection.

1. The pumper should be connected to a city hydrant.
2. The hydrant should be on a large main, assuring a better supply than is available from one of the private hydrants. (Private hydrants generally are provided for direct hose lines in unsprinklered plants, for piles of lumber or other stock in the yard, or for fires in the outside of buildings.)
3. At least two lines should be connected to the sprinkler siamese connection and an adequate discharge pressure should be maintained at the pump. (About 10 to 12 sprinkler heads can be supplied effectively by a single 2½-inch pumper line.)
4. Pump pressures - normal pump operating pressure of 150 P. S. I. should be maintained.
5. Discharge capacities.
   a. The following table taken from N. F. P. A. shows the discharge capacities of approved sprinklers having ½-inch orifice, or its equivalent, in discharge at various pressures up to 100 pounds.

Pressure at Head	G.P.M.
10	18
15	22
20	25
25	28
35	34
50	41
75	50
100	58

   b. Thumb rule for determining gallons per minute from sprinkler

head with ½-inch orifice. (½ pressure plus 15 = G.P.M.).

SAMPLE: With 20 P.S.I. at each sprinkler head, each head would discharge the following:

½ of 20 or 10 plus 15 = 25 G.P.M.

V. Hose Streams in a Building Equipped With Sprinklers.

A. Hose streams may be needed to protect exposures or to assist sprinklers at a fire in piled stock or concealed spaces.

B. It is not a good practice to take water from mains directly supplying the sprinkler system if separate mains or other sources of supply are available.

C. In general, the industrial fire brigade should find that 50 G.P.M. streams, from nozzles capable of either fog or straight streams, are adequate for fires in sprinklered buildings.

D. The use of several such streams would impose a burden on the water systems far less than that of two or more 250 G.P.M. solid streams.

VI. Summary.

Fighting fires in plants protected with private fire protection calls for exact knowledge regarding sources of water and their capacities, details of piping, knowledge of the functions of valves and the fire department connection, as well as numerous other details which cannot be thoroughly explained in this written text. Therefore, each fire brigade must be thoroughly familiar with fire protection of their plant.

References:

Bond, Horatio and Kimball, Warren Y. Industrial Fire Brigades. Boston, Massachusetts: National Fire Protection Association.

The National Fire Codes, Fixed Extinguishing Equipment. Boston, Massachusetts, 1974-75.

PART XI: FIRE CAUSES AND HAZARDS

I. Purpose.

To function efficiently, a plant fireman must know something of the causes of fire and the conditions under which fires may be expected. (Review the fire triangle under Part III of this manual.)

II. Determining Possible Fire Causes.

Fire results principally from the combination of combustible materials and oxygen which produces light and heat.

A. Combustible materials or fuel - normally exist in three physical states.

1. Solid - wood, paper, or coal.
2. Liquid - gasoline, alcohol, or oil.
3. Gas - natural, acetylene, or hydrogen.

B. Oxygen - amounts that support burning.

1. 21 percent - normal content in the air.
2. 16 percent - critical amount for producing flame.

C. Heat.

1. A fuel must be heated to its ignition temperature before burning can take place.
2. For continued burning, there must not only be sufficient temperature but there must also be a sufficient quantity of heat.

III. Sources of Ignition.

A. Open flames and heaters - smoking, torches, gas flames, lamps, furnaces, ovens, heaters, chemical reaction.

B. Electricity - arcing (sparking), lightning, static.

C. Friction - hot bearings, rubbing belts, grinding, polishing, cutting, drilling.

D. Spontaneous heating or chemical reaction.

IV. Heat Transfer.

A. Conduction (example).

B. Radiation (example).

C. Convection (example).

V. Locating and Dealing With Fire Hazards.

A. Fire hazard - a condition that will encourage a fire to start.

B. Principal groups of materials referred to as hazards.

1. Light combustibles such as thin plywood, shingles, shavings, paper, cotton, and other fibers.
2. Combustible gases.
3. Flammable liquids.
4. Combustible liquids.
5. Materials subject to spontaneous heating.
6. Explosive materials and hazardous chemicals.

C. Housekeeping hazards - the plant fire brigade should be concerned with:

1. The efficiency of the cleaning force in removing debris and rubbish.
2. The use of special cans provided for the storage of oily waste.
3. The proper storage and disposal of ashes.
4. The proper storage, handling and use of flammable, combustible or hazardous stock in conformance with the plant safety rules.
5. The proper enforcement of the rules regarding smoking.

NOTE: Conditions that do not conform with the above should be reported to the proper authority and corrective measures should be taken.

D. Heating hazards.

1. Heating hazards may be considered for the following general classes of heaters:

a. Furnaces and heating devices are graded according to:

(1) The temperature at which they operate.

(2) Their settings and maintenance.

(3) The clearances from combustibles.

(4) The fuel used (coal, wood, oil, electricity, gas).

(5) The general features of their installation.

(6) The automatic temperature controls.

b. Furnace stacks, chimneys and flues - (condition and installation).

c. Portable heaters and salamanders - (approved and unapproved for location).

2. The factors discussed on the generation and transfer of heat have practical application in the control of fires from heating devices.

E. Chemicals, paints, and oils.

1. Where chemicals of any kind are used.

a. Determine their hazardous characteristics.

b. Determine if they are properly stored and handled.

2. The handling and use of paints and oils also present hazards.

a. Stocks in white lead, zinc, and colors ground in oil do not present hazards within themselves. However, the oil is

combustible and will burn freely when heated to ignition temperature, and under some circumstances may cause spontaneous ignition.

b. A serious hazard is presented when materials such as rags, paper, and sawdust are used around paints and oils and become soaked

F. Spontaneous ignition - (sometimes misnamed "spontaneous combustion").

1. Definition - "ignition by the internal development of heat" (chemical action).

2. The fire brigade members should take extra precautions against spontaneous ignition:

a. Oils with vegetable base.

(1) Linseed oil.

(2) Soy bean oil.

(3) Olive oil.

(4) Tung oil.

b. Some finely divided metals will ignite spontaneously on exposure to air.

c. Charcoal - should be kept thoroughly dry.

d. Wood - when subjected to prolonged exposure to temperatures of a low order (steam pipes) may ignite spontaneously. The formation of porous carbon or charcoal on the surface of the wood exposed to the heat may be the underlying cause of ignition.

e. Organic substances, such as hay, grain, straw, etc. should be kept dry.

3. Fire brigade members should bear in mind that everything oiled is dangerous, and that moisture promotes spontaneous ignition.

G. Dust explosions - the dust from any ordinary combustible materials or oxidizable metals will explode when mixed with air in the proper proportions if ignited by a flame or spark.

1. Primary explosion - may be in a comparatively small area that is in contact with the ignition cause.
2. Secondary explosion - may be quite extensive because primary explosion jars accumulated dust loose, throwing it into the air.
3. Prevention.
   a. Elimination of dust production.
   b. Collect and dispose of dust as it accumulates.
   c. Keep away open flames or other possible ignition sources.

H. Flammable liquids - the distinction between a flammable liquid and a liquid which is combustible lies in the ease with which it gives off flammable vapors.

1. Flammable liquids - gasoline, alcohol, acetone, fuel oil, etc.
2. Combustible liquids - lubricating, vegetable or fish oils or glycerine, etc.

   NOTE: Any combustible liquid, heated sufficiently, becomes flammable. It may also become flammable if dispersed in a very fine spray.

3. Flash point - the lowest temperatures at which a liquid gives off sufficient vapors which can be ignited by a spark or flame.
   a. The lower the flash point, the greater the hazard.
   b. Some examples and their flash points:

(1) Carbon disulphide -22° F.

(2) Ether -49° F.

(3) Gasoline -45° F.

(4) Alcohol $+55^{\circ}$ F.

4. Ignition temperature - the minimum temperature to which a substance must be heated to cause self-sustained combustion.

5. Explosive range - the range between the upper and lower explosive limits of a flammable vapor or gas.

   a. Lower explosive limit - the percentage of vapor mixed with air below which an explosion cannot occur (mixture too lean).

   b. Upper explosive limit - the percentage above which there is not sufficient air for an explosion (mixture too rich).

6. When flammable liquid vapors are heavier than air:

   a. They will accumulate in basements and pits.

   b. They can flow long distances unseen, finally reaching some source of ignition and flashing back.

7. Identification of flammable liquids is often difficult.

   a. Smell is not a reliable indication, but may be a signal that investigation is needed.

   b. Trade names usually give no clue to the fire hazard.

   c. In case of doubt, get a laboratory test of flash point.

8. Storage of flammable liquids.

   a. Use proper closed containers as far as possible for storage and handling.

b. Approved pumps should be used for withdrawing liquids from tanks or drums.

c. Sources of ignition should be excluded from any room where flammable liquids are used or stored.

d. No smoking.

e. No open flame or processing equipment.

f. Explosion-proof electrical equipment and installation.

References:

Bond, Horatio and Kimball, Warren Y. Industrial Fire Brigade. Boston, Massachusetts: National Fire Protection Association.

The National Fire Codes, Volume I. Flammable Liquids and Gases. Boston, Massachusetts, 1974-75.